



Department of Energy

Ohio Field Office Fernald Area Office

P. O. Box 538705
Cincinnati, Ohio 45253-8705
(513) 648-3155



4237

12 MAR 2002

Mr. Ken Alkema, President
Envirocare of Utah, Inc.
46 West Broadway, Suite 240
Salt Lake City, Utah 84101

DOE-0372-02

Dear Mr. Alkema:

11(e)(2) BYPRODUCT WASTE STREAM CERTIFICATION FOR FERNALD ENVIRONMENTAL MANAGEMENT PROJECT SILOS MATERIAL

This letter and enclosure are provided as certification of Fernald Environmental Management Project (FEMP) Silos 1, 2, & 3 contents as 11(e)(2) byproduct material consistent with 42 U.S.C.2014(e)(2). Certification of this material is offered to satisfy the Nuclear Regulatory Commission (NRC) and State of Utah classification requirement for cell placement prior to in-ground disposal at Envirocare.

42 U.S.C.2014(e)(2) defines the term byproduct material as "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." While in production, the FEMP uranium processing facility provided high-purity uranium metal products in support of the Nation's defense program. These products were generated from the processing of high assay uranium ores and ore concentrates. The material in FEMP silos is waste resulting from this beneficiation process, i.e., extraction of uranium for its source material and is considered to be 11(e)(2) byproduct material by the Department of Energy (DOE).

The DOE has always considered these wastes to be 11(e)(2) byproduct material and has always regulated them as such. Silo wastes at FEMP have been managed under DOE Orders and on DOE property from the time they were placed into storage in the silos. The Atomic Energy Commission, and subsequently the DOE, had authority to manage their own wastes without requirement of a NRC specific license. However, the Silo wastes at Fernald were managed similar to commercial wastes regulated under a NRC license. Essentially, DOE regulation of the Silo wastes is equivalent to the regulation of commercial wastes via NRC license. Additionally, as these materials are proposed for disposal at a commercial facility, they should be managed in a facility designed for disposal of 11(e)(2) byproduct.

12 MAR 2002

Mr. Ken Alkema

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DOE-0372-02

Draft waste profiles, which provide documentation supporting the DOE classification of the silo material, are enclosed. These profiles have been drafted utilizing process knowledge and historical site investigation data. While every effort has been taken to provide complete profile packages, these are draft documents offered for informational purposes to support waste classification and are not offered to satisfy Envirocare Waste Acceptance Criteria. Final waste profiles will be submitted to Envirocare for review and approval prior to potential waste conveyance activities.

DOE requests Envirocare provide a schedule for the NRC/State of Utah review and approval of license amendment application. If you should have any questions or require additional information, please contact Nina Akgündüz at (513) 648-3110.

Sincerely,

FEMP:Akgündüz

for 
Stephen H. McCracken
Director

Enclosure: As Stated

K. Loveland, Envirocare of Utah, Inc.
B. Rogers, Envirocare of Utah, Inc.
N. Akgündüz, OH/FEMP
J. Hall, OH/FEMP
J. Reising, OH/FEMP
J. Sattler, OH/FEMP
J. Buckley, Fluor Fernald, Inc./MS52-3
D. Carr, Fluor Fernald, Inc./MS2
R. Corradi, Fluor Fernald, Inc./MS77
T. Hagen, Fluor Fernald, Inc./MS65-2
K. Sparks, Fluor Fernald, Inc./MS52-5

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FERNALD SILO 1, 2 & 3 11.e(2) WASTE PROFILE**TABLE OF CONTENTS**

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RADIOACTIVE WASTE PROFILE RECORD

(EC-0230)

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(11/21/95)

Generator Name: U.S. Dept. of Energy ; Generator #/Waste Stream #: _____ ; Vol. of Waste Material: 75K cu yd.
 Contractor Name: Fluor Daniel Fernald ; Waste Stream Name: Silo 1&2 11.e(2) ; Deliv. Date: 05/01/2005
 Check appropriate boxes: Licensed Y N X ; NORM/NARM _____ ; LLRW _____ ; MW _____ ; MW Treated _____ ; MW Needing Trtmt _____ ; DOE _____ ; 11e.(2) X
 Original Submission: Y X N _____ ; Revision # 0 _____ ; Date of Revision _____
 Name & Title of Person Completing Form: Keith Sparks, Commercial Waste Disposal Phone (513) 648-5731

A. CUSTOMER INFORMATION:

GENERAL: Please read carefully and complete this form for one waste stream. This information will be used to determine how to properly manage the waste. Should there be any questions while completing this form, contact Envirocare at (801) 532-1330. **WASTES CANNOT BE ACCEPTED AT ENVIROCARE UNLESS THIS FORM IS COMPLETED.** If a category does not apply, please indicate. This form must be updated annually.

1. GENERATOR INFORMATION

EPA ID # N/A EPA Hazardous Waste Number(s) (if applicable) N/A
 Mailing Address: U.S. Dept. of Energy, Fernald Site, P.O. Box 538705, Cincinnati, OH 45253-8705
 Phone: 513/648-3155 Fax 513/648-3071
 Location of Material (City, ST): Fernald, OH
 Generator Contact: Nina Akgunduz Title Operable Unit 4 Team Leader
 Mailing Address (if different from above): N/A
 Phone: (513) 648-3110 Fax (513) 648-3076

B. WASTE PHYSICAL PROPERTIES (Should you have any questions while completing this section, contact Envirocare Customer Support Representative at (801) 532-1330.)

1. **PHYSICAL DATA** (Indicate percentage of material that will pass through the following grid sizes, e.g., 12" 100%, 4" 96%, 1" 74%, 1/4" 50%, 1/40" 30%, 1/200", 5%.)

GRADATION OF MATERIAL:

	12"	<u>N/A</u>	%
2. DESCRIPTION: Color <u>Grey and Brown</u> Odor <u>N/A</u>	4"	<u>N/A</u>	%
Liquid _____ Solid <u>X</u> Sludge _____ Powder/Dust _____	1"	<u>N/A</u>	%
	1/4"	<u>N/A</u>	%
3. DENSITY RANGE: (Indicate dimensions) <u>63</u> - <u>125</u> lb./ft ³	1/40"	<u>N/A</u>	%
	1/200"	<u>N/A</u>	%

4. GENERAL CHARACTERISTICS (% OF EACH)

Soil _____ Building Debris _____ Rubble _____ Pipe Scale _____ Tailings 20 Process Waste _____ Concrete 80 Plastic/Resin _____
 Other constituents and approximate % contribution of each: paper, plastic, PPE, absorbent, misc., Inert contact waste: <10%

5. MOISTURE CONTENT: (For soil or soil-like materials.) (Use Std Proctor Method ASTM D-698)

Optimum Moisture Content: N/A %
 Average Moisture Content: N/A - N/A
 Moisture Content Range: N/A - N/A %

6. DESCRIPTION OF WASTE (Please attach a description of the waste with respect to its physical composition and characteristics. This description can be attached separately or included with the attachment for Item D.1.). SEE ATTACHMENT A - "Process Knowledge Information"

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C. RADIOLOGICAL EVALUATION. SEE ATTACHMENT B - "Radiochemical Analysis Summary Spreadsheet", AND ATTACHMENT D - "Laboratory Analytical Data Support Package".

1. **WASTE STREAM INFORMATION.** For each radioactive isotope associated with the waste, please list the following information. Envirocare's license assumes daughter products to be present in equilibrium, these are not required to be listed below and do not require manifesting. (Use additional copies of this form if necessary.)

	Isotopes	Concentration Range		17 % Loading Wtd Average (pCi/g)		Isotopes	Concentration Range		17 % Loading Wtd Average (pCi/g)	
		15% (pCi/g)	20%				15% (pCi/g)	20%		
a.	<u>Ra-226</u>	<u>99</u>	<u>to 100,000</u>	<u>81,090</u>		g.	<u>U-238</u>	<u>7</u>	<u>to 385</u>	<u>327</u>
b.	<u>Th-228</u>	<u>62</u>	<u>to 1,472</u>	<u>1,251</u>		h.	<u>Ac-227</u>	<u>436</u>	<u>to 3,478</u>	<u>2,956</u>
c.	<u>Th-230</u>	<u>1,255</u>	<u>to 26,560</u>	<u>22,576</u>		i.	<u>Pa-231</u>	<u>606</u>	<u>to 809</u>	<u>687</u>
d.	<u>Th-232</u>	<u>99</u>	<u>to 222</u>	<u>188</u>		j.	<u>Pb-210</u>	<u>7,347</u>	<u>to 79,840</u>	<u>67,864</u>
e.	<u>U-234</u>	<u>18</u>	<u>to 310</u>	<u>263</u>		k.				
f.	<u>U-235</u>	<u>3</u>	<u>to 35</u>	<u>29</u>		l.		<u>to</u>		

2. ☒ Is the radioactivity contained in the waste material Low-Level Radioactive Waste as defined in the Low-Level Radioactive Waste Policy Amendments Act of 1985 or in DOE Order 5820.2A, Chapter III? (Please Circle) If yes, check "LLRW" block on line 3 of page 1.
3. ☒ **LICENSED MATERIAL:** Is the waste material listed or included on an active Nuclear Regulatory Commission or Agreement State License? (Please Circle)

(If Yes) TYPE OF LICENSE: Source ☐; Special Nuclear Material ☐; By-Product ☒; NORM ☐; NARM ☐;

LICENSING AGENCY: _____

D. CHEMICAL AND HAZARDOUS CHARACTERISTICS

1. **DESCRIPTION AND HISTORY OF WASTE** SEE ATTACHMENT A - "Process Knowledge Information"

Please attach a description of the waste to this profile. Include the following as applicable: The process by which the waste was generated. Available process knowledge of the waste. The basis of hazardous waste determinations. A list of the chemicals and materials used in or commingled with the waste; a list of any and all applicable EPA Hazardous Waste Numbers, current or former; and, a list of any and all applicable land-disposal prohibition or hazardous-waste exclusions, extensions, exemptions, effective dates, variances, or delistings. Attach the most recent or applicable analytical results involving the composition of the waste. Attach any product information or treatment standards. Attach any applicable analytical results involving the composition of the waste. Attach any product information or Material Safety Data Sheets associated with the waste. If a category on this Waste Profile Record does not apply, describe why it does not.

Please describe the history, and include the following:

- ☒ Was this waste mixed, treated, neutralized, solidified, commingled, dried, or processed upon generation or at any time thereafter?
- ☒ Has this waste been transported or otherwise removed from the location or site where it was originally generated?
- ☒ Was this waste derived from (or the waste a residue of) treatment, storage, and/or disposal of hazardous waste defined by 40 CFR 261?
- ☒ Has this material been treated at any time to meet any applicable treatment standard?

2. **LIST ALL KNOWN AND POSSIBLE CHEMICAL COMPONENTS OR HAZARDOUS WASTE CHARACTERISTICS**

	(Y)	(N)		(Y)	(N)		(Y)	(N)
a. Listed HW		X	b. "Derived-From" HW		X	c. Toxic		X
d. Cyanides		X	e. Sulfides		X	f. Dioxins		X
g. Pesticides		X	h. Herbicides		X	i. PCBs	X	
j. Explosives		X	k. Pyrophorics		X	l. Solvents	X	
m. Organics	X		n. Phenolics		X	o. Infectious		X
p. Ignitable		X	q. Corrosive		X	r. Reactive		X
s. Antimony		X	t. Beryllium		X	u. Copper	X	
v. Nickel	X		w. Thallium		X	x. Vanadium		X
y. Alcohols		X	z. Arsenic	X		aa. Barium	X	
bb. Cadmium	X		cc. Chromium	X		dd. Lead	X	
ee. Mercury	X		ff. Selenium	X		gg. Silver		X
hh. Benzene		X	ii. Nitrate		X	jj. Nitrite		X
kk. Fluoride		X	ll. Oil		X	mm Fuel		X
nn. Chelating Agents		X						
oo. Other Known or Possible Materials or Chemicals								

Tri-butyl phosphate (TBP), Kerosene

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3. **ANALYTICAL RESULTS FOR TOXICITY CHARACTERISTIC.** (Please transcribe results on the blank spaces provided. Attach additional sheets if needed, indicate range or worst-case results). SEE ATTACHMENT C - "Chemical Analysis Summary Spreadsheet" AND ATTACHMENT D - "Laboratory Analytical Data Support Package".

Metals (circle one): Total (mg/kg) or				Organics (circle one) Total (mg/kg) or TCLP (mg/l)			
Arsenic	264	Lead	50,830	PCBs	<reg limit	32 Organic TCLP	<MDL
Barium	3,383	Mercury	1				
Cadmium	2	Selenium	58				
Chromium	10	Silver	4				
Copper	139	Zinc	16				

4. **ANALYTICAL RESULTS FOR REQUIRED PARAMETERS:** (Please transcribe results on the blank spaces provided. Attach additional sheets if needed). SEE ATTACHMENT D - "Laboratory Analytical Data Support Package"

Soil pH	6.91 to 12.21	Paint Filter Liquids Test	Pass (Pass/Fail)	Cyanide Released	0.00107 mg/kg	Sulfide Released	0.045 mg/kg
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5. **IGNITABILITY (40 CFR 261.21[a][2],[4].)**

Flash Point \geq .140 °F Is the waste a RCRA oxidizer? N

6. **CHEMICAL COMPOSITION** (List all known chemical components and circle the applicable concentration dimensions. Use attachments to complete, if necessary.)

Chemical Component	Concentration	Chemical Component	Concentration
N/A	% mg/kg		% mg/kg
	% mg/kg		% mg/kg
	% mg/kg	Halogenic Organic (HOC)	N/A
	% mg/kg	Compounds (Sum of the list of HOCs.)	N/A mg/kg

7. **TREATMENT STANDARDS. (FOR MIXED WASTE ONLY).** Describe the waste's applicable treatment standards. Include the EPA Hazardous Waste Numbers and information with respect to the waste's subcategory (e.g., low mercury subcategory), treatability group (e.g. non-wastewaters), treatment standards and concentrations or technology (e.g. 5.7 mg/l selenium extract or INCIN [incineration]), and any applicable exemptions, exclusions, variances, extension, allowances, etc. The following format is suggested. If additional space is needed, provide an attachment to this profile record.

EPA HW Number	Subcategory	Treatability Group	Treatability Standard(s) and Concentrations or Technology	Any Exemptions, Variances, Extensions or Exclusions (List 40 CFR reference)
N/A	N/A	N/A	N/A	[Y N] N/A
				[Y N]

- E. **REQUIRED CHEMICAL LABORATORY ANALYSIS.** Generator must submit results of analyses of the waste. Results are required from a qualified laboratory for the following analytical parameters unless nonapplicability of the analysis for the waste can be stated and justified in attached statements. Attach all analytical results and QA/QC documentation. (CAUTION: PRIOR TO ARRANGING FOR LABORATORY ANALYSES, CHECK WITH ENVIROCARE AND LABORATORY REGARDING UTAH LABORATORY CERTIFICATIONS).

SEE ATTACHMENT D - "Laboratory Analytical Data Support Package"

FOR ALL WASTE TYPES: CHEMICAL ANALYSIS: Soil pH (9045), Paint Filter Liquids Test (9095); Reactivity (cyanide and sulfide).

1. **MINIMUM ADDITIONAL ANALYTICAL REQUIRED FOR:**

- Non-RCRA Waste (Non Mixed Waste, i.e. LLRW, NORM): TCLP including the 32 organics, 8 metals, and copper (Cu) and zinc (Zn).
- Mixed Waste: Results to show why the waste is hazardous, and the following analytical results:
 - TOX (Total Organic Halides SW-846 9020/9022) or volatile & semi-volatile organics (8240+8270, required if TOX >200 mg/kg)
 - Applicable concentration-based treatment standards
 - Total and Amenable Cyanide, SW-846 9010 or 9012, required if reactive cyanide >20 mg/kg

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2. **REQUIRED RADIOLOGICAL ANALYSES:** Please obtain sufficient samples to adequately determine a range and weighted average of activity in the waste. Have a sufficient number of samples analyzed by gamma spectral analysis for all natural and man-made isotopes such that they support the range and weighted average information for the waste stream that will be recorded in item D.1. If Uranium, Plutonium, Thorium, or other non-gamma emitting nuclides are present in the material, have at least (1) sample evaluated by radiochemistry to determine the concentration of these additional contaminants in the material. **SEE ATTACHMENTS B AND D.**

3. **PRE-SHIPMENT SAMPLES OF WASTE TO ENVIROCARE**

Once permission has been obtained from Envirocare, please send 5 representative samples of the waste to Envirocare. A completed EC-2000 form must be included with the sample containers. These samples will be used to establish the waste's incoming shipment acceptance parameter tolerances and may be analyzed for additional parameters. Send about two pounds (one liter) for each sample in an air-tight clean glass container via United Parcel Post (UPS) or Federal Express to:

Envirocare of Utah, Inc., Attn: Sample Control, Tooele County, Interstate-80, Exit 49, Clive, Utah 84029
For Federal Express Use Zip Code 84083). Phone: (801) 521-9619

4. **LABORATORY CERTIFICATION INFORMATION.** Please indicate below which of the following categories applies to your laboratory data.

- a. Note analytical data that is to represent mixed waste must be Utah certified or from the USEPA. All radiological data used to support the data in item C.1. must be from a Utah-certified laboratory.

UTAH CERTIFIED. The laboratory holds a current certification for the applicable chemical or radiologic parameters from the Utah Department of Health insofar as such official certifications are given.

GENERATOR'S STATE CERTIFICATION. The laboratory holds a current certification for the applicable chemical parameters from the generator's State insofar as such official certifications are given, or

GENERATOR'S STATE LABORATORY REQUIREMENTS. The laboratory meets the requirements of the generator's State or cognizant agency for chemical laboratories, or:

If using a non-Utah certified laboratory, briefly describe the generator state's requirements for chemical analytical laboratories to defend the determination that the laboratory used meets those requirements, especially in terms of whether the requirements are parameter specific, method specific, or involve CLP or other QA data packages. Note: When process or project knowledge of this waste is applied, additional analytical results may not be necessary to complete Section B, D.2, D.5, or D.6 of this form.

- b. For analytical work done by Utah-certified laboratories, please provide a copy of the laboratory's current certification letter for each parameter analyzed and each method used for analyses required by this form.
- c. For analytical work done by laboratories which are not Utah-Certified, please provide the following information:

State or Other Agency Contact Person

Generator's State

Telephone Number

Lab Contact Person

Laboratory's State

Telephone Number

F. **CERTIFICATION**

GENERATOR'S CERTIFICATION OF REPRESENTATIVE SAMPLES, ANALYTICAL RESULTS FROM QUALIFIED LABORATORIES, USE OF APPROVED ANALYTICAL AND SAMPLING METHODS, AND ARRANGEMENTS FOR TREATMENT OR NON-PROHIBITED DISPOSAL. I certify that samples representative of the waste described in this profile were or shall be obtained using state- and EPA-approved sampling methods. I also certify that where necessary those representative samples were or shall be provided to Envirocare and to qualified laboratories for the analytical results reported herein. I further certify that the waste described in this record is not prohibited from land disposal in 40 CFR 268 (unless prior arrangements are made for treatment at Envirocare) and that all applicable treatment standards are clearly indicated on this form. I also certify that the information provided on this form is complete, true and correct and is accurately supported and documented by any laboratory testing as required by Envirocare of Utah, Inc. I certify that the results of any said testing have been submitted to Envirocare of Utah, Inc.

Generator's Signature _____
(Sign for the above certification).

Title _____

Date _____

RADIOACTIVE WASTE PROFILE RECORD

(EC-0230)

(11/21/95)

Generator Name: U.S. Dept. of Energy ; Generator #/Waste Stream #: 6010-08 ; Vol. of Waste Material: 6,000 cu yd.
 Contractor Name: Fluor Fernald ; Waste Stream Name: Silo 3 11e.(2) ; Deliv. Date: 10/01/2002
 Check appropriate boxes: Licensed Y ☐ N ☒ ; NORM/NARM ☐ ; LLRW ☐ ; MW ☐ ; MW Treated ☐ ; MW Needing Trtmt ☐ ; DOE ☐ ; 11e.(2) X ☒
 Original Submission: Y ☐ N ☒ ; Revision # 1 ; Date of Revision 5, March 2002
 Name & Title of Person Completing Form: Keith Sparks, Commercial Waste Disposal Phone (513) 648-5731

A. CUSTOMER INFORMATION:

GENERAL: Please read carefully and complete this form for one waste stream. This information will be used to determine how to properly manage the waste. Should there be any questions while completing this form, contact Envirocare at (801) 532-1330. **WASTES CANNOT BE ACCEPTED AT ENVIROCARE UNLESS THIS FORM IS COMPLETED.** If a category does not apply, please indicate. This form must be updated annually.

1. GENERATOR INFORMATION

EPA ID # N/A EPA Hazardous Waste Number(s) (if applicable) N/A
 Mailing Address: U.S. Dept. of Energy, Fernald Site, P.O. Box 538705, Cincinnati, OH 45253-8705
 Phone: 513/648-3155 Fax 513/648-3071
 Location of Material (City, ST): Fernald, OH
 Generator Contact: Nina Akgunduz Title Operable Unit 4 Team Leader
 Mailing Address (if different from above): N/A
 Phone: (513) 648-3110 Fax (513) 648-3076

B. WASTE PHYSICAL PROPERTIES (Should you have any questions while completing this section, contact Envirocare Customer Support Representative at (801) 532-1330.)

1. **PHYSICAL DATA** (Indicate percentage of material that will pass through the following grid sizes, e.g., 12" 100%, 4" 96%, 1" 74%, 1/4" 50%, 1/40" 30%, 1/200", 5%.)

GRADATION OF MATERIAL:

2. DESCRIPTION: Color <u>Brown</u> Odor <u>N/A</u>	12" <u>100</u> %
Liquid <input type="checkbox"/> Solid <input checked="" type="checkbox"/> Sludge <input type="checkbox"/> Powder/Dust <input checked="" type="checkbox"/>	4" <u>100</u> %
	1" <u> </u> %
	1/4" <u> </u> %
3. DENSITY RANGE: (Indicate dimensions) Proctor max. unit wt. <u>63 - 100 lb/ft³</u>	1/40" <u> </u> %
	1/200" <u> </u> %

4. GENERAL CHARACTERISTICS (% OF EACH)

Soil ☐ Building Debris ☐ Rubble <5 Pipe Scale ☐ Tailings ☐ Process Waste 95 Concrete ☐ Plastic/Resin ☐
 Other constituents and approximate % contribution of each: Paper, plastic, PPE, misc. inert materials: 1%

5. MOISTURE CONTENT: (For soil or soil-like materials.) (Use Std Proctor Method ASTM D-698)

Optimum Moisture Content: %
 Average Moisture Content: 6.9 %
 Moisture Content Range: 2.31 - 10.2 %

6. DESCRIPTION OF WASTE (Please attach a description of the waste with respect to its physical composition and characteristics. This description can be attached separately or included with the attachment for Item D.1.). SEE ATTACHMENT A.

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C. RADIOLOGICAL EVALUATION. SEE ATTACHMENT B (spreadsheet) AND ATTACHMENT C (lab data packages).

1. **WASTE STREAM INFORMATION.** For each radioactive isotope associated with the waste, please list the following information. Envirocare's license assumes daughter products to be present in equilibrium, these are not required to be listed below and do not require manifesting. (Use additional copies of this form if necessary.) **NOTE: Six additional constituents listed on supplemental page.**

	Isotopes	Concentration Range (pCi/g)	Weighted Average (pCi/g)		Isotopes	Concentration Range (pCi/g)	Weighted Average (pCi/g)
a.	Ra-226	467 to 6435	3870	g.	U-235	42 to 158	117
b.	Pa-231	266 to 931	627	h.	U-238	320 to 2043	1780
c.	Th-228	459 to 1400	747	i.	Pb-210	454 to 6427	3480
d.	Th-230	21010 to 71650	60000	j.	Ac-227	234 to 1363	925
e.	Th-232	411 to 1451	842	k.			
f.	U-234	348 to 2000	1730	l.			

2. ☒ Is the radioactivity contained in the waste material Low-Level Radioactive Waste as defined in the Low-Level Radioactive Waste Policy Amendments Act of 1985 or in DOE Order 5820.2A, Chapter III? (Please Circle) If yes, check "LLRW" block on line 3 of page 1.
3. ☒ **LICENSED MATERIAL:** Is the waste material listed or included on an active Nuclear Regulatory Commission or Agreement State license? (Please Circle)

(If Yes) **TYPE OF LICENSE:** Source ☐ ; Special Nuclear Material ☐ ; By-Product ☒ ; NORM ☐ ; NARM ☐ ;

LICENSING AGENCY: _____

D. CHEMICAL AND HAZARDOUS CHARACTERISTICS

1. **DESCRIPTION AND HISTORY OF WASTE (SEE ATTACHMENT A.)**

Please attach a description of the waste to this profile. Include the following as applicable: The process by which the waste was generated. Available process knowledge of the waste. The basis of hazardous waste determinations. A list of the chemicals and materials used in or commingled with the waste; a list of any and all applicable EPA Hazardous Waste Numbers, current or former; and, a list of any and all applicable land-disposal prohibition or hazardous-waste exclusions, extensions, exemptions, effective dates, variances, or delistings. Attach the most recent or applicable analytical results involving the composition of the waste. Attach any product information or treatment standards. Attach any applicable analytical results involving the composition of the waste. Attach any product information or Material Safety Data Sheets associated with the waste. If a category on this Waste Profile Record does not apply, describe why it does not.

Please describe the history, and include the following:

- ☒ Was this waste mixed, treated, neutralized, solidified, commingled, dried, or otherwise processed upon generation or at any time thereafter?
- ☒ Has this waste been transported or otherwise removed from the location or site where it was originally generated?
- ☒ Was this waste derived from (or the waste a residue of) treatment, storage, and/or disposal of hazardous waste defined by 40 CFR 261?
- ☒ Has this material been treated at any time to meet any applicable treatment standard?

2. **LIST ALL KNOWN AND POSSIBLE CHEMICAL COMPONENTS OR HAZARDOUS WASTE CHARACTERISTICS**

	(Y)	(N)		(Y)	(N)		(Y)	(N)
a. Listed HW		X	b. "Derived-From" HW		X	c. Toxic		X
d. Cyanides		X	e. Sulfides		X	f. Dioxins		X
g. Pesticides		X	h. Herbicides		X	i. PCBs		X
j. Explosives		X	k. Pyrophorics		X	l. Solvents		X
m. Organics		X	n. Phenolics		X	o. Infectious		X
p. Ignitable		X	q. Corrosive		X	r. Reactive		X
s. Antimony		X	t. Beryllium		X	u. Copper	X	
v. Nickel	X		w. Thallium		X	x. Vanadium		X
y. Alcohols		X	z. Arsenic	X		aa. Barium	X	
bb. Cadmium	X		cc. Chromium	X		dd. Lead	X	
ee. Mercury		X	ff. Selenium	X		gg. Silver	X	
hh. Benzene		X	ii. Nitrate		X	jj. Nitrite		X
kk. Fluoride		X	ll. Oil		X	mm Fuel		X
nn. Chelating Agents		X						
oo. Other Known or Possible Materials or Chemicals								

N/A

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3. ANALYTICAL RESULTS FOR TOXICITY CHARACTERISTIC. (Please transcribe results on the blank spaces provided. Attach additional sheets if needed, indicate range or worst-case results). SEE ATTACHMENT C (lab data packages)

Metals (circle one): <u>Total (mg/kg)</u> or TCLP (mg/l)				Organics (circle one) <u>Total (mg/kg)</u> or TCLP (mg/l)			
Arsenic	<u>3170</u>	Lead	<u>2380</u>	PCBs	<u><reg limit</u>	32 Organic TCLP	<u><MDL</u>
Barium	<u>278</u>	Mercury	<u>.07</u>				
Cadmium	<u>94</u>	Selenium	<u>229</u>				
Chromium	<u>395</u>	Silver	<u>18</u>				
Copper	<u>3340</u>	Zinc	<u>535</u>				

4. ANALYTICAL RESULTS FOR REQUIRED PARAMETERS: (Please transcribe results on the blank spaces provided. Attach additional sheets if needed). SEE ATTACHMENT C (lab data packages)

Soil pH	<u>5.91 to 12.21</u>	Paint Filter Liquids Test	<u>Pass</u> (Pass/Fail)	Cyanide Released	<u>0.00107</u> mg/kg	Sulfide Released	<u>0.045</u> mg/kg
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5. IGNITABILITY (40 CFR 261.21[a][2],[4].)

Flash Point \geq 140 °F °C Is the waste a RCRA oxidizer? Y N

6. CHEMICAL COMPOSITION (List all known chemical components and circle the applicable concentration dimensions. Use attachments to complete, if necessary.) SEE ATTACHMENT C (lab data packages)

Chemical Component	Concentration	Chemical Component	Concentration
<u>N/A</u>	% mg/kg		% mg/kg
	% mg/kg		% mg/kg
	% mg/kg		% mg/kg
	% mg/kg	Halogenic Organic (HOC) Compounds (Sum of the list of HOCs.)	<u>N/A</u> mg/kg

7. TREATMENT STANDARDS. (FOR MIXED WASTE ONLY). Describe the waste's applicable treatment standards. Include the EPA Hazardous Waste Numbers and information with respect to the waste's subcategory (e.g., low mercury subcategory), treatability group (e.g. non-wastewaters), treatment standards and concentrations or technology (e.g. 5.7 mg/l selenium extract or INCIN [incineration]), and any applicable exemptions, exclusions, variances, extension, allowances, etc. The following format is suggested. If additional space is needed, provide an attachment to this profile record.

EPA HW Number	Subcategory	Treatability Group	Treatability Standard(s) and Concentrations or Technology	Any Exemptions, Variances, Extensions or Exclusions (List 40 CFR reference)
<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	[Y N] <u>N/A</u>
				[Y N]

E. REQUIRED CHEMICAL LABORATORY ANALYSIS. Generator must submit results of analyses of the waste. Results are required from a qualified laboratory for the following analytical parameters unless nonapplicability of the analysis for the waste can be stated and justified in attached statements. Attach all analytical results and QA/QC documentation. (CAUTION: PRIOR TO ARRANGING FOR LABORATORY ANALYSES, CHECK WITH ENVIROCORE AND LABORATORY REGARDING UTAH LABORATORY CERTIFICATIONS).

SEE ATTACHMENT C (lab data packages)

FOR ALL WASTE TYPES: CHEMICAL ANALYSIS: Soil pH (9045), Paint Filter Liquids Test (9095); Reactivity (cyanide and sulfide).

1. MINIMUM ADDITIONAL ANALYTICAL REQUIRED FOR:

- Non-RCRA Waste (Non Mixed Waste, i.e. LLRW, NORM): TCLP including the 32 organics, 8 metals, and copper (Cu) and zinc (Zn).
- Mixed Waste: Results to show why the waste is hazardous, and the following analytical results:
 - TOX (Total Organic Halides SW-846 9020/9022) or volatile & semi-volatile organics (8240+8270, required if TOX > 200 mg/kg)
 - Applicable concentration-based treatment standards
 - Total and Amenable Cyanide, SW-846 9010 or 9012, required if reactive cyanide > 20 mg/kg

000010

2. **REQUIRED RADIOLOGICAL ANALYSES:** Please obtain sufficient samples to adequately determine a range and weighted average of activity in the waste. Have a sufficient number of samples analyzed by gamma spectral analysis for all natural and man-made isotopes such that they support the range and weighted average information for the waste stream that will be recorded in item D.1. If Uranium, Plutonium, Thorium, or other non-gamma emitting nuclides are present in the material, have at least (1) sample evaluated by radiochemistry to determine the concentration of these additional contaminants in the material. **SEE ATTACHMENTS B AND C.**

3. **PRE-SHIPMENT SAMPLES OF WASTE TO ENVIROCARE**

Once permission has been obtained from Envirocare, please send 5 representative samples of the waste to Envirocare. A completed EC-2000 form must be included with the sample containers. These samples will be used to establish the waste's incoming shipment acceptance parameter tolerances and may be analyzed for additional parameters. Send about two pounds (one liter) for each sample in an air-tight clean glass container via United Parcel Post (UPS) or Federal Express to:

Envirocare of Utah, Inc., Attn: Sample Control, Tooele County, Interstate-80, Exit 49, Clive, Utah 84029
For Federal Express Use Zip Code 84083). Phone: (801) 521-9619

4. **LABORATORY CERTIFICATION INFORMATION.** Please indicate below which of the following categories applies to your laboratory data.

- a. Note analytical data that is to represent mixed waste must be Utah certified or from the USEPA. All radiological data used to support the data in item C.1. must be from a Utah-certified laboratory.

☒ **UTAH CERTIFIED.** The laboratory holds a current certification for the applicable chemical or radiologic parameters from the Utah Department of Health insofar as such official certifications are given. **SEE ATTACHMENT D FOR UTAH CERTIFICATION.**

☐ **GENERATOR'S STATE CERTIFICATION.** The laboratory holds a current certification for the applicable chemical parameters from the generator's State insofar as such official certifications are given, or

☒ **GENERATOR'S STATE LABORATORY REQUIREMENTS.** The laboratory meets the requirements of the generator's State or cognizant agency for chemical laboratories, or:

If using a non-Utah certified laboratory, briefly describe the generator state's requirements for chemical analytical laboratories to defend the determination that the laboratory used meets those requirements, especially in terms of whether the requirements are parameter specific, method specific, or involve CLP or other QA data packages. Note: When process or project knowledge of this waste is applied, additional analytical results may not be necessary to complete Section B, D.2, D.5, or D.6 of this form.

- b. For analytical work done by Utah-certified laboratories, please provide a copy of the laboratory's current certification letter for each parameter analyzed and each method used for analyses required by this form.
- c. For analytical work done by laboratories which are not Utah-Certified, please provide the following information:

State or Other Agency Contact Person

Generator's State

Telephone Number

Lab Contact Person

Laboratory's State

Telephone Number

F. **CERTIFICATION**

GENERATOR'S CERTIFICATION OF REPRESENTATIVE SAMPLES, ANALYTICAL RESULTS FROM QUALIFIED LABORATORIES, USE OF APPROVED ANALYTICAL AND SAMPLING METHODS, AND ARRANGEMENTS FOR TREATMENT OR NON-PROHIBITED DISPOSAL. I certify that samples representative of the waste described in this profile were or shall be obtained using state- and EPA-approved sampling methods. I also certify that where necessary those representative samples were or shall be provided to Envirocare and to qualified laboratories for the analytical results reported herein. I further certify that the waste described in this record is not prohibited from land disposal in 40 CFR 268 (unless prior arrangements are made for treatment at Envirocare) and that all applicable treatment standards are clearly indicated on this form. I also certify that the information provided on this form is complete, true and correct and is accurately supported and documented by any laboratory testing as required by Envirocare of Utah, Inc. I certify that the results of any said testing have been submitted to Envirocare of Utah, Inc.

Generator's Signature _____
(Sign for the above certification).

Title _____

Date _____

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ATTACHMENT A**"PROCESS KNOWLEDGE NARRATIVE"**

ATTACHMENT A

"PROCESS KNOWLEDGE NARRATIVE"

B. WASTE PHYSICAL PROPERTIES

1. *Physical Data - Gradation of material:*

Waste in this profile is comprised of refinery processed pitchblend ores, containing a high concentration of radioactive uranium progeny, known as "hot" raffinates, absorbent material, and less than 10 percent inert debris. Material comprising the inert debris consists of miscellaneous paper, PPE, and plastic/plastic bags. Waste in this profile will be treated via chemical stabilization to satisfy Record of Decision (ROD) commitments. Silo 1&2 final waste form will exist as a stabilized and solidified matrix packaged into ¼ inch carbon steel containers, placed in gondolas, and shipped by rail for disposal. Silo 3 will be packaged in three (3) yard bags without treatment. Due to the radiological nature of this waste stream, material will not be removed from the packaging for placement in the 11e.(2) cell. Therefore, the containers of waste will not pass through the sieve gradations specified in the waste profile.

2. *Description of Waste:*

Color: The color description for this waste stream based on visual inspection performed during ongoing "proof of process"/treatability studies and is as follows:

Varying shades of gray solids with brownish, black, and white specks. Clear and black plastic, and some white and off-white pads with stained gray and black areas. Colors are consistent with traditional cement stabilized waste.

Odor: Slight organic odors might be present from treatment additives and new packaging, otherwise, no additional odors present.

This profile contains waste that is 100% solid in composition and comprised of the three categories:

Solidified Silo 1&2 Waste

- Chemically stabilized and solidified "Hot" raffinates

000013

Untreated Silo 3 Waste

- Directly packaged calcined "Cold" raffinates

Debris

- Miscellaneous paper, absorbent pads, absorbent material (< 1 % by weight), PPE, and plastic/plastic bags (all primarily contact waste).

3. *Density Range:*

The treated waste matrix will solidify to a monolith that will support a Vicat needle prior shipment. Waste density, established from RI/FS data, "proof of process" and treatability studies provide a waste density ranging from 65 to 125 lb./ft³. Treated waste density could vary, slightly, depending on batch operations and "phasing" of insitu material. However, the average treated waste density is of approximately 95 lb./ft³. Silo 3 density range is from 63 to 100 95 lb./ft³.

4. *General Characteristics of Material (% of Each):*

MATERIAL

% OF EACH MATERIAL

Solidified Silo 1&2 Waste

- | | |
|---|------|
| › "hot" raffinates:
(dry basis, including 2.2% Bentogrout) | ~20% |
| › Concrete:
(Water, Fly ash, Portland cement,
Phosphate, Alum, and Polyelectrolyte) | ~80% |
| › Absorbent Material | <01% |

Untreated Silo 3 Waste

- | | |
|---------------------|------|
| › "cold" raffinates | ~95% |
| › Inert Debris | <10% |

5. *Moisture Content:*

Silo 1&2 waste will be treated via chemical stabilization and solidified into solid waste prior to shipment for disposal. Waste will exist as a "dry" solid not requiring compaction. Therefore, moisture and proctor data are not required nor provided. However, absorbent pads and/or absorbent material will be added to each container in this profile to address any potential free liquid, which may be released during incident of normal transportation as a FEMP risk management precautionary measure. Addition of absorbent material will not exceed one (1) percent by weight per container. MSDS(s) for the absorbent mixture are included in Attachment F - "MSDS".

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Silo 3 waste was calcined to an average moisture content of 6.9%. This waste will not be treated, however, will be packaged and transported for direct disposal.

6. *Description of Waste:*

Waste in this profile was generated from the extraction and/or concentration of uranium and/or thorium from ore processed primarily for its source material content. Visual inspections and "proof of process"/treatability studies coupled with process knowledge have determined that silo 1&2 material exists primarily as stabilized and solidified byproduct residues exhibiting traditional physical characteristics of chemically stabilized residues, and does not contain any additional radiological or hazardous waste. Silo 3 waste has undergone calcining and exists as a "talcum powder-like" waste form with varying chunks of hardened material. Refer to item D - **CHEMICAL AND HAZARDOUS CHARACTERISTICS**, section 1 - *Description and History of Waste* for additional waste stream details.

C. **RADIOLOGICAL EVALUATION**

Radiological evaluation of this waste stream includes assessment of process knowledge, analytical results, and site scaling factors and Material Control and Accountability (MC&A) calculations. Silos were sampled in 1989 and again in 1990/1991 to provide data for the original Remedial Investigation and Feasibility Studies (RI/FS). Radionuclide analytical results from both sampling efforts are summarized in Attachment B - "Radiochemical Analysis Summary Spreadsheet". Whenever activity values differ between analytical results, and scaling factors and MC&A calculations, the more conservative value(s) are disclosed.

Attachment B - "Radiochemical Analysis Summary Spreadsheet" provides a list of the constituents that were detected in the silos during both sampling efforts. The table shows that the predominant constituents in terms of activity in Silo 1 include: actinium (Ac)-227, lead (Pb)-210, polonium (Po)-210, radium (Ra)-226, and thorium (Th)-230. This information is consistent with process knowledge that the hot raffinates contain primarily U-238 decay products. Though present, Th-230 is not in secular equilibrium with Ra-226, confirming that thorium was not fully precipitated during the refining process that generated the hot raffinates. As expected, other radionuclides out of secular equilibrium are present in relatively low concentrations, including U-234, U-235, and U-238. Members of the Th-232 decay series are also present (Th-232, Th-228, and Ra-228).

These are the "primary" radiological constituents of concern for the silos. These constituents were observed in the highest relative concentrations and are generally associated with former uranium ore processing operations conducted at the FEMP. This

waste stream contains waste with a U-235 activity ranging from 19.1pCi/g to 172pCi/g. The U-235 concentration will not reach, nor exceed the 1,900pCi/g SNM limit. The following paragraphs discuss the strategy for declaring the maximum and weighted average concentration levels for radiological constituents associated with this waste stream.

The sampling programs for the characterization of this material employed gamma spectroscopy, alpha spectroscopy, and ICP-MS uranium enrichment analysis for the radiological constituents listed. Attachment B - "Radiochemical Analysis Summary Spreadsheet" presents the analytical results for the identified radiological constituents, and establishes a pre-treatment range, post-treatment maximum and weighted average concentrations for each constituent as requested in Item C.1 of the Profile Record.

Radiological analysis was performed of this waste stream and analytical results exist in Attachment B - "Radiochemical Analysis Summary Spreadsheet". Laboratory analytical support data packages supporting this effort are included in Attachment D -- "Laboratory Analytical Support Package."

Radiological Composition

The waste in Silo 1 was generated from pitchblende ore containing 40 to 50% U_3O_8 . Based on this fact, and assuming that all Ra-226 is precipitated in the hot raffinate, the mass of raffinate into which the radium is concentrated is approximately one-fourth the original mass of the ore. The remaining mass (75%) was classified as cold raffinate and exists in Silo 3. The U-238 concentration in Silo 1 suggests an efficiency of greater than 99.8% for the digestion and carbonate treatment process.

Silo 2 sampling results reveal that the predominant constituents include Ac-227, Pb-210, Po-210, Ra-226, and Th-230. These nuclides are consistent with the process knowledge that the hot raffinates contain mostly U-238 decay products. Similar to Silo 1, Th-230 is present in Silo 2 but not in secular equilibrium with Ra-226. The results suggest that only 10% to 25% of the Th-230 precipitated with the hot raffinate.

As expected, other radionuclides are present from the Th-232 decay chain and the U-235 decay chain. The U-238 concentration suggests efficiency greater than 99.6% in the extraction process for uranium.

Summary of Radiological Results

The predominant radiological constituents in Silos 1 and 2 are Ac-227, Pb-210, Po-210, Ra-226, and Th-230. The 1990/1991 concentrations are, for some radionuclides, at least twice the 1989 concentrations. This variance is attributed to the 1989-sampling event not collecting representative samples from the bottom half of the silos where activity is most concentrated. Silo 3 primary radiological constituents are Pb-210, Ra-226, Th-230, U-234 and U-238.

There is a general increase in the concentrations of radiological constituents with depth in all manways. Radiological constituent concentrations are similar horizontally, across the silos and from manway to manway. Although this characteristic is not consistent for all the predominant constituents, there is a discernable trend. This trend probably results from the placement at different times of the material in the silos as layers of slurries.

CHEMICAL AND HAZARDOUS CHARACTERISTICS

1. *Description and History of Waste:*

Background

The Feed Materials Production Center (FMPC), now known as the Fernald Environmental Management Project (FEMP) site is owned by the U.S. Department of Energy (DOE) and was operated from 1952 to 1989. While in operation, the uranium ore processing facility provided high-purity uranium metal products in support of the nation's defense program.

In May 1951, the Atomic Energy Commission, predecessor to the DOE, initiated construction operations at the FMPC. Full-scale production was initiated after pilot operations began in 1952 and continued until July 1989. Production ceased in the summer of 1989 and plant resources were directed toward environmental remediation activities. The facility was formally closed by congressional authorization in June 1991.

These remedial actions also addresses FEMP's OU4. OU4 includes the following facilities and associated environmental media: Silos 1&2 and their contents; Silo 3 and its contents; an empty Silo 4; the decant sump; a radon treatment system; a portion of a concrete pipe trench and other concrete structures; an earthen berm surrounding Silos 1&2; soils beneath and immediately surrounding Silos 1, 2, 3, and 4; perched groundwater in the vicinity of the silos that are encountered during the implementation of remedial actions. However, waste offered for disposal under this profile only includes Silo 1&2 contents.

Originally constructed in 1951 and 1952, three of the four reinforced concrete storage silos within OU4 received by-product materials until 1960. Silos 1 and 2 received K-65 residues generated from the processing of high assay uranium ores at the FEMP and Mallinckrodt Chemical Works (MCW) in St. Louis, MO. The ores processed at MCW and the vast majority of ores processed at the FEMP came primarily from one mine located in Zaire. These ores contained relatively high concentrations of uranium oxides in the range of 40 to 50 percent as well as high concentrations of radium.

Operational History of Silo 1&2

This section provides an abbreviated operational history of the Silos 1 and 2 material. An understanding of the origin and process history of the Silos 1 and 2 material is necessary in order to understand the basis for the regulatory classification of the material and the

applicability of the ARARs. The regulatory classification of the Silos 1 and 2 material and the approved ARARs are fundamental drivers for the unique technical and safety requirements for removing, treating, packaging, transporting, and disposing the material. For further discussion of the regulatory classification of Silo 1&2 material, see the following section - Regulatory Classification.

The Feed Materials Production Center (FMPC) refinery processed two basic classes of materials: (1) mined pitchblende ores from the Shinkolobwe Mine in the Belgian Congo, the Rum Jungle Mine, and the Radium Hill Mine in Australia; and, (2) other uranium concentrates that had already been refined to some degree. The second class of materials included uranium concentrates that had undergone a preliminary refining process at an off-site mill and material recovered at various stages of FMPC operations. The term "K-65" was used to describe the processing of both the Belgian Congo and the Australian ores.

Uranium-bearing ores, as they are mined, contain not only uranium, but also equilibrium (activity) concentrations of uranium progeny [i.e., the isotopes of other elements formed through the sequential, radioactive decay chains that begin with uranium (U)-235 and U-238. These progenies, which include radium, are removed either in a preliminary milling process or in the refining process (if the ores are not preprocessed through a mill). Thus, when the FMPC refinery processed pitchblende ores, the refinery wastes contained a high concentration of the radioactive uranium progeny. These refinery wastes were known as "hot" raffinates. The term "hot" was used to indicate that the materials contained a high concentration of the radionuclide radium and gamma-emitting progenies that result in a significant direct penetrating radiation exposure rate.

Liquid "hot" raffinates were filtered. Resulting filter cake contained most of the radium as insoluble barium-radium sulfate. The filter cake was re-slurried, neutralized, and pumped to Silo 2. [The filtrate along with non-pitchblende raffinates from other FMPC production runs was evaporated, calcined, and pneumatically conveyed to Silo 3 as "cold" metal oxides. However, some of the radium remained with the filtrate, and some of the thorium progeny of uranium (i.e., thorium-230) remained within the non-pitchblende uranium concentrates due to the inefficiency of the source mill in removing this metal. Thus, although the materials are called "cold," they are radioactive.]

The material stored in Silo 1 was generated at Mallinckrodt Chemical Works (MCW) in St. Louis, Missouri, as a result of processing to extract uranium from pitchblende ores.

The pitchblende ores processed at MCW and the great majority of the pitchblende ores processed at the FMPC site came from one mine, the Shinkolobwe Mine in the Belgian Congo. These ores contained relatively high concentrations of uranium oxide (U_3O_8), in the range of 40 to 50%.

Initially, the materials from the MCW refining operations were sent back to the African

Metals Corporation. Beginning in April 1949, the materials were no longer returned to the African Metals Corporation following processing; they were stored at MCW for future disposition and later, ownership of the Silos 1 and 2 material was transferred to the U.S. Department of Energy - Fernald Environmental Management Project (DOE-FEMP).

As production continued, storage became a problem. Therefore, the drummed K-65 materials were sent from MCW to the Lake Ontario Ordnance Works (LOOW) near Niagara Falls, New York, for storage. Some of the drums that were sent to LOOW were emptied into a concrete water tower at that site. Approximately 6,000 drums were shipped from LOOW to the FMPC site for storage. Beginning in 1951, continued production at the MCW resulted in approximately 25,000 drums being sent directly from St. Louis to the FMPC site.

Before construction of the FMPC refinery, MCW operated a refinery for the production of uranium. The MCW refinery used a dual-cycle ether process that was somewhat different from the tributyl phosphate (TBP)-kerosene extraction system used at the FMPC site. Another difference between the FMPC process and the MCW refinery operation was the method used to extract radium and other impurities from the uranium. Unlike the FMPC process, impurities were removed from the K-65 materials at MCW in the ore digestion process before the uranium extraction system.

The removal of uranium from pitchblende at MCW consisted of milling the ores to pass a 100-mesh sieve and, secondly, a 3-hour leach in concentrated nitric acid, which resulted in the radium precipitating as radium sulfate (RaSO_4). Barium sulfate (BaSO_4) was added during digestion to ensure co-precipitation. If insufficient sulfide was present in the ore, sulfuric acid (H_2SO_4) was added to ensure the precipitation of radium and lead. The precipitated materials were vacuum-filtered, then re-slurried and digested with sodium carbonate (Na_2CO_3) and sodium formate (NaHCO_2). This second digestion process was to recover approximately 2% of the original uranium, which remained in this waste fraction. The second digestion also led to the precipitation of impurities including ferric, aluminum, and manganese hydroxides. Following the carbonate leach, the slurry was again vacuum-filtered and packaged in drums as K-65 materials. Much of the thorium (most importantly Th-230), as a nitrate, remained soluble and traveled in solution with the uranyl nitrate to the extraction process area. Therefore, Th-230 is not present in secular equilibrium with radium in the K-65 materials.

Approximately 24,000 of the 31,000 drums of pitchblende ore processing materials received at the FMPC site from MCW and LOOW were transferred to Silo 1 for storage.

The remaining 7,000 drums of K-65 materials received from MCW and LOOW were transferred to Silo 2. As the drums were received by railroad car at the FMPC site, the drums were temporarily staged in an area to the east of Silos 3 and 4. The drummed material was transferred to Silo 1 from July 1952 until November 1953 via a specially constructed Drum Handling Building.

The K-65 Drum Handling Building received drummed material from MCW and LOOW locations and transferred the material into Silos 1 and 2. A block diagram of this process is presented in Figure 1.

Wet solids were delivered to the K-65 Drum Handling Building in 55-gal drums, each containing approximately 230 kilograms (kg) (500 lb.) of material. The material had a bulk density of approximately 1.44 grams/cubic centimeter (g/cm^3) (90 lbs/ft³) and contained approximately 40% moisture by weight. One drum of material was handled at a time.

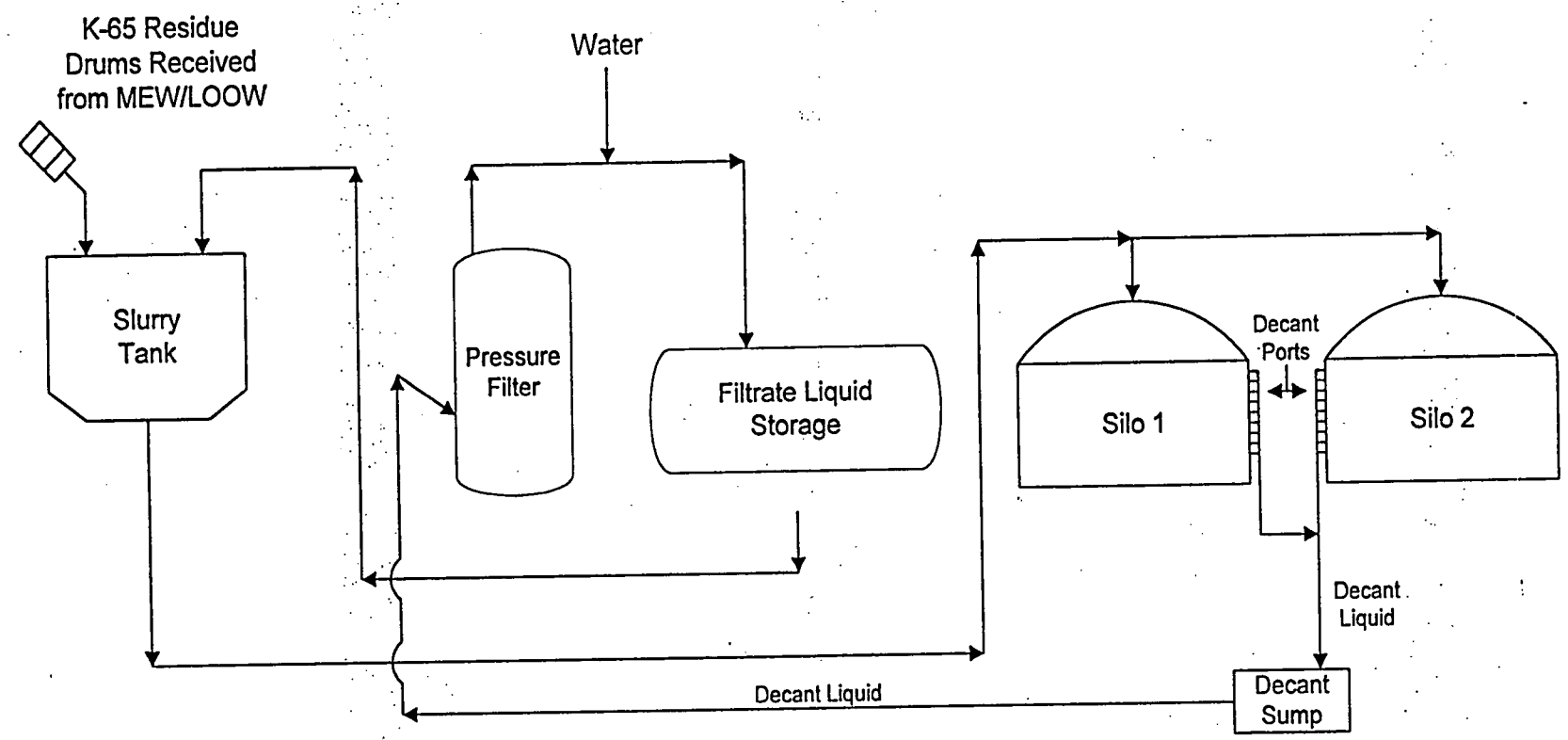
Each drum was placed on a slat conveyor and moved inside the building. There it was placed onto a skip hoist and raised to a point above the slurry tank, where it was inverted. The contents of the drum were dumped into the slurry tank by vibration, aided by a high-velocity water jet. The water jet also washed the drum, which was eventually returned to the conveyor and removed from the building. Approximately 280 liters (L) [75 gal] of slurring liquor, which was fresh water during initial operations, were consumed in removal of the solids from one drum. The resulting slurry, which had a consistency of approximately 4 pounds (lb.) of wet solids per gallon of slurry, was continuously agitated in the slurry tank.

When approximately 7,570 L (2,000 gal) of slurry had been produced, the contents of the slurry tank were pumped to storage in Silo 1. This slurry pumping was followed by a 6,250-liter (1,650-gal) clear liquor wash that was passed through the slurry tank, slurry pump, transfer line, and into the storage silo.

The slurries pumped into storage Silo 1 were allowed to settle into two layers. The slurry liquor, which consisted of either water or a metal nitrate solution, formed the top layer over a bed of the settled, wet solids. This layer of liquid was decanted from the silos through the decant ports and placed into the decant sump tank.

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FIGURE 1
HOT RAFFINATE FROM K-65 DRUMMED WASTE HANDLING FACILITY



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From here, the decanted liquid was periodically pumped back to the Drum Handling Building where it passed through a pressure filter and was stored in a filtrate storage tank. The filtrate storage tank was located within the Drum Handling Building on the concrete pad, forming the floor of the structure. The filtered liquid was then used for slurry preparation in the K-65 Drum Handling Building. Excess liquids were transported back to the FMPC Plant 8 for treatment, then to the General Sump for final treatment before being discharged to the Great Miami River. The K-65 Drum Handling Building was demolished in 1983 to allow for installation of the earthen berm.

Although MCW processed the pitchblende ores by batch runs on the incoming ores from the Shinkolobwe Mine, no conscious attempt was made at Fernald to transfer the material to the silos by the original MCW batch or lot number. Therefore, the materials within Silo 1 represent a range of processing runs at MCW, displaying the variations present in the natural ores and the generating production process.

While Silo 1 consists solely of transferred drummed materials from MCW and LOOW, Silo 2 is a mixture of MCW K-65 materials and FMPC-generated K-65 materials. As previously stated, 7,000 drums of K-65 materials transferred from MCW and LOOW to Fernald were emptied into Silo 2. The transfer of the drummed materials received from off-site into Silo 2 occurred between late 1953 and January 1956. The generating process and the methodology to transfer the MCW/LOOW materials into Silo 2 are similar to those used in Silo 1, as discussed in the previous section.

Additionally, Silo 2 received materials that were generated at the FMPC site (resulting from the processing of pitchblende ores shipped directly from the Shinkolobwe Mine) and a small quantity of Australian ores (from the Rum Jungle Mine and the Radium Hill Mine). The processing completed at the FMPC site was performed to extract the uranium from these very rich pitchblende ores. Belgian Congo ores were processed from May 1954 until August 1958. Australian ores were processed following the Belgian ores from May 1957 until March 1958. The last K-65 slurry was added to Silo 2 in January 1959. The Australian ore residues constitute less than 180,000 kg (200 tons) of the estimated 4.4 million kg (4,900 tons) in Silo 2.

Fernald-generated material in Silo 2 is a by-product of refinery operations conducted in Plant 2/3 and supporting structures at the facility. Pitchblende ores were received at Plant 1 of the FMPC site where the ores were thawed (if necessary), milled, and assayed for their uranium content. Milling, performed to facilitate the digestion process, took place in a Williams Mill where the ores were ground until they could pass a 100-mesh sieve. The milled ores, following assay, were conveyed to the Plant 1 ore silos for storage until they were processed in the refinery (Plant 2/3).

At the refinery, the milled ores were transferred to digester tanks by batch. Each batch varied from 1,820 to 2,270 kg (4,000 to 5,000 lb.) of uranium and 2,270 to 4,550 kg

(5,000 to 10,000 lb.) of net feed. Nitric acid and water were added to the ores in the digesters to yield a final slurry concentration of 200 grams (g) of uranium per liter and 3 Normal excess nitric + acid. Following a typical 3-hour digestion, the digest slurry was transferred to a feed holding tank in the extraction area of the refinery.

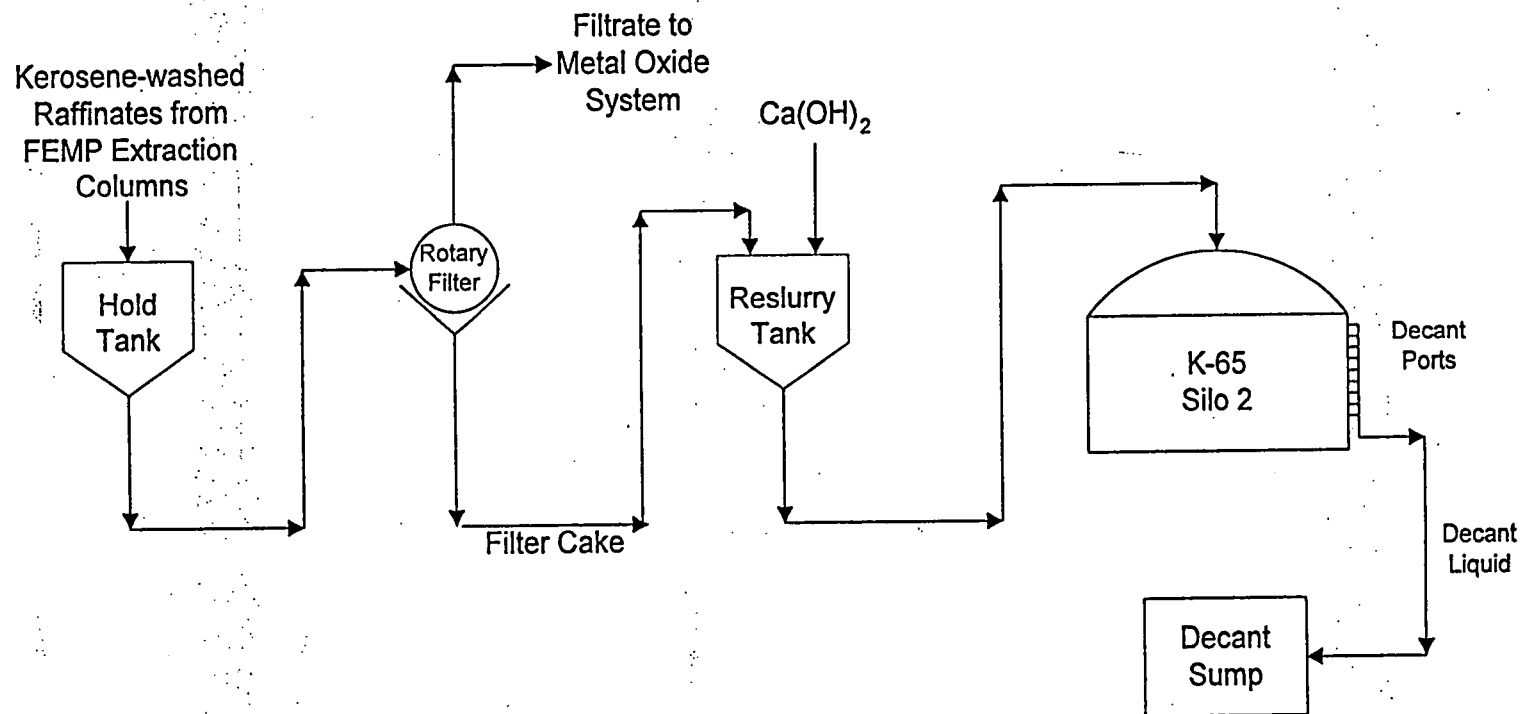
The uranium extraction system at the FMPC site, at the time of K-65 processing, employed a series of three perforated plate pulse columns, including an extraction column, a scrub column, and a re-extraction column. The aqueous feed slurry from the hold tank was introduced into the top of the extraction column. An organic extractant, 33.5% by volume TBP in an inert purified kerosene diluent, was introduced into the bottom of the same extraction column. The combined liquid phases were pulsed through the stationary perforated plates, with the aqueous feed slurry passing down and the organic phase moving up through the column. The organic extractant flow rate and the feed stream flow rate were controlled to maintain a constant uranium saturation level in the organic product stream. The uranyl nitrate solution was removed from the aqueous feed slurry by the organic extractant. Extraction of the uranium from the ores was essentially complete when the organic product stream left the top of the extraction column.

The remaining metals and other impurities in the pitchblende ores were left the bottom of the extraction column. This by-product stream was known as K-65 raffinates. The K-65 raffinates were freed of the organic phase in a disengagement chamber at the base of the extraction column. Despite this disengagement process, considerable quantities of entrained TBP remained in the raffinate leaving the column. In order to recover these reusable concentrations of TBP, the raffinates were transferred to a single stage mixer settler to be combined with continuously recycled kerosene.

The TBP extraction system was relatively specific toward uranyl nitrate; other nitrate compounds, such as thorium nitrate, present in the feed slurry were physically entrained in the organic product phase leaving the extraction column. In order to remove these impurities from the feed stream and achieve product quality standards, a second purification step was performed in the scrub column. In the scrub column, the organic product stream from the extraction column entered the bottom while deionized water entered the top of the column. During the continuous flow through the scrub column, essentially all of the remaining metallic impurities were transferred to the aqueous phase, together with a small quantity of uranium. The aqueous phase was directed back to the extraction column to recover the remaining uranyl nitrate. The pure organic phase continued through the final re-extraction column where the TBP-kerosene was separated from the uranyl nitrate. The operation of the re-extraction column is not relevant to the generation of the K-65 materials and is, therefore, not presented. The impurities residing in the aqueous phase from the scrub column were transferred to the K-65 raffinates leaving the extraction column.

The kerosene-washed K-65 raffinates were filtered through a pre-coated rotary vacuum filter to remove suspended solids (Figure 2). Most of the gamma-emitting uranium progeny and radium were filtered out in this step. Filtrate was passed on to the cold metal, oxide process for transfer to Silo 3. The filter cake from the rotary filter contained the gamma-emitting uranium progeny; therefore, it was termed "hot raffinate." This filter cake was re-slurried and then neutralized with lime $[\text{Ca}(\text{OH})_2]$. The resulting slurry had a consistency of about 0.5 kg of wet solids per liter of slurry (4 lb. of wet solids/1 gal of slurry). Once each day during refinery operation, the hot raffinate slurry was pumped into Silo 2 through a 7.6-cm (3-inch) Schedule 80-transfer line located in a concrete trench that extended from the refinery to the silos. This slurry transfer was followed by a 4,500- to 5,500-liter (1,200- to 1,500-gal) process water wash to clean the transfer line.

FIGURE 2
HOT RAFFINATE FLOW TO SILO 2



Following completion of K-65 processing operations at the FMPC site, approximately 150 drums of radium-contaminated material, consisting of soils from the MCW/LOOW drum staging area, cleanup materials, and excess K-65 samples, were placed into Silo 2 in June 1960. In response to concerns of the FMPC Operating Contractor [National Lead of Ohio (NLO), Inc.] regarding chronic Rn-222 emissions from the silos, all vents, manways, and other penetrations through the domes of Silos 1 and 2 were sealed in 1979. Material (with the exception of decant liquid and samples) has not been removed from Silos 1 or 2 since the final filling.

Regulatory Classification

In 1978 Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) directing the Environmental Protection Agency to promulgate cleanup standards (40 Code of Federal Regulations 192) and assigning the Nuclear Regulatory Commission to oversee the cleanup and license the cleanup facilities. The scope of environmental restoration includes all costs for waste management, program management, and landlord activities attributable to the Department of Energy.

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) governs environmental restoration of uranium production sites including mill tailings. UMTRCA (Public Law 95-604), the basis for present-day control of uranium mill sites in the United States, vests the U.S. Environmental Protection Agency (EPA) with overall responsibility for establishing environmental standards and guidelines under "Health and Environmental Protection Standards for Uranium and Uranium Mill Tailings" (40 CFR Part 192). Regulatory responsibility, however, remains with the U.S. Nuclear Regulatory Commission (NRC), which issues operating licenses under 10 CFR Part 40, "Domestic Licensing of Source Material," and enforces regulations in conformance with UMTRCA.

UMTRCA established two regimes for the regulation of sites where ores containing uranium or thorium have been milled or are still being milled. Title I of the act, the focus here, established a remedial action program for the inactive milling sites managed by DOE.

Under Title I, the NRC exerts its regulatory role largely through 1) concurrence in DOE's plans for remedial action, 2) consultation in the execution of these plans, and 3) concurrence in DOE's determination that remedial action has been completed in compliance with the plans. When the NRC concurs in DOE's determination, either DOE or another Federal agency designated by the President becomes an NRC licensee with responsibility for long-term care of the remediated site.

As a result, in 1978 the U.S. Department of Energy (DOE) initiates Uranium Mill Tailings Remedial Action (UMTRA) Project under UMTRCA Title I.

On December 15, 2000, the NRC issued a Director's Position that any waste produced from the extraction of uranium and thorium, prior to the enactment of Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978, could be regulated by the USNRC. This pre-UMTRCA waste was designated by the NRC as Technically Enhanced Naturally Occurring Radioactive Material (TENORM), a subset of Naturally Occurring Radioactive

Material (NORM), regulated by the states. The only exception to this policy decision was that any pre-UMTRCA waste licensed by the NRC or an agreement state after the enactment of UMTRCA was to be regulated as 11e.(2) material.

In response to a request by Envirocare, the NRC made a determination concerning pre-UMTRCA waste at Maywood, New Jersey where the NRC had licensed some of the site activities post UMTRCA enactment. The conclusion of the review of the Maywood wastes was that the subject wastes were 11e.(2) wastes.

Silo wastes at Fernald have been managed under DOE Orders and on DOE property from the time they were deposited in the 1950's until today. The Atomic Energy Commission (AEC) and subsequently the DOE had authority to manage their own wastes without requirement of an NRC specific license. However, the Silo wastes on AEC/DOE property at Fernald were managed similar to commercial wastes that had an NRC license. Essentially, the DOE regulation of the Silo wastes was equivalent to the regulation of commercial wastes via an NRC license. The AEC and DOE have always considered these wastes to be 11e.(2) wastes and has always internally regulated them as 11e.(2) wastes.

Conclusions

The Fernald Silo wastes are 11e.(2) by-product tailings resulting from refinery extraction processing of pitchblend ores and must be regulated under NRC regulations or under DOE orders promulgated for the disposal of 11e.(2) wastes. Additionally, as these materials are proposed for disposal at a commercial facility (Envirocare of Utah), they must be managed in their 11e.(2) cell/facility.

Silos Material Characterization

- This subsection summarizes the radiological and chemical characterization of the Silos material.

Chemical Composition

Chemically, the contents of Silos are mixtures of hydroxides, carbonates, and sulfates. Carbonates and sulfates compose approximately 20% of the waste. The primary form of uranium contained in the Silos material is sodium uranyl carbonate (Dettorre et al. 1981). Other Elements contributing at least 1% to the total are calcium, iron, magnesium, and lead.

Inorganic Constituents

Twenty-seven inorganic metals were detected in Silo 1 during the 1989 and 1990/1991 sampling efforts (see Attachment C - "Chemical Analysis Summary Spreadsheet"). The results of the Hazardous Substance List (HSL) analyses show that the predominant inorganic constituents in Silo 1 are barium, calcium, iron, and lead. Other metallic constituents at relatively lower concentrations include aluminum, cobalt, magnesium, molybdenum, nickel, selenium, and silicon. Frequency of detection was high for all constituents.

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Predominant inorganic constituents detected through general chemistry analysis include chloride, nitrate, phosphorus, sulfate, and organic carbon. Their concentrations are also shown in Attachment C - "Chemical Analysis Summary Spreadsheet". The results are consistent with those of previous studies and those expected for byproduct of uranium ore processing.

Analytical data from both the 1989 and 1990/1991 sampling of Silo 2 show similar concentrations for the predominant metallic constituents. These constituents include: barium, calcium, iron, and lead. Other metallic constituents detected at lower concentrations than those previously listed include aluminum, arsenic, cobalt, copper, magnesium, nickel, silicon, and sodium. The predominant inorganic constituents detected through general chemistry analysis are the same as those for Silo 1.

Organic Constituents

The Silo 1 analytical results show detection of 25 organic compounds, which include polychlorinated biphenyls (PCBs) and semivolatile and volatile organics. Aroclor-1248, aroclor-1254, and aroclor-1260 were detected at concentrations well below regulatory concentrations. Detection of aroclor-1248, aroclor-1254, and aroclor-1260 are due to the introduction of PCBs through cleaning and the lubrication of processing and raffinate handling equipment. No PCBs were used directly in the processing of ore. Analytical results coupled with process knowledge support the determination that this byproduct material is not a PCB regulated waste stream. Other constituents detected generally included either common laboratory contaminants or infrequently detected constituents. Tributyl phosphate was detected in Silo 1, which was unexpected because that material was not part of the MCW refinement process. However, the tributyl phosphate was probably introduced by the liquid used to slurry the waste for placement into the silo.

Silo 2 organic results detected 16 compounds including aroclor-1254, aroclor-1260, and tributyl phosphate. Again, detection of aroclors is due to the introduction of PCBs through cleaning and the lubrication of processing and raffinate handling equipment. No PCBs were used directly in the processing of ore. Analytical results coupled with process knowledge support the determination that this byproduct material is not a PCB regulated waste stream.

Organics are not expected to be present in any substantive concentration in Silo 3 due to the high temperature calcining process.

Tributyl phosphate was present at a mean concentration of 29 mg/kg, which was consistent with process knowledge and demonstrates that the tributyl phosphate recovery system was not totally effective. The concentrations of the other organics in Silo 2 were near detection levels.

HSL volatile organic data from the 1989 sampling of Silos 1 and 2 were rejected during validation due to missed sample holding times. Results for polynuclear aromatic hydrocarbons (PAH) are not seriously effected by extended holding times and can remain basically unchanged for years. Aroclors (PCBs) were detected at very low concentrations due to being very persistent and show little tendency toward degradation, either chemically

or biologically. Therefore, data for these analytes were retained during validation, while other analyses for semivolatile organic compounds were rejected for missed holding times. The important fact to note is that the PCB results were well below regulatory limits.

TCLP Analysis

Samples collected in 1989 were analyzed using the extraction procedure (EP) TOX test, while those collected in 1990/1991 were analyzed using the Toxicity Characteristic Leaching Procedure (TCLP 1993) extraction followed by a full TCLP analysis of the extract. Sample analytical results for these tests are presented in Attachment C - "Chemical Analysis Summary Spreadsheet". Each of these tables also includes a column entitled maximum allowable concentration. The values shown in this column are taken from 40 Code of Federal Regulations (CFR) Part 261.24 and represent those values that characterize a solid waste as exhibiting the toxicity characteristic under the Resource Conservation and Recovery Act (RCRA), as amended (RCRA 1976). The material in the Silos, however, is Atomic Energy Act (AEA) 11(e)(2) by-product material and are specifically excluded under RCRA from the definition of solid waste (40 CFR Part 261.4(a)(4)). These values are shown in the table only as reference values used by the industry to determine whether waste is hazardous by toxicity characteristics.

The results of the 1989 EP Toxicity tests are summarized in Attachment C - "Chemical Analysis Summary Spreadsheet". Samples from Silos 1 and 2 yielded leachable lead that exceeded the maximum allowable concentration of 5 mg/L for the toxicity characteristics specified in 40 CFR Part 261.24. The maximum lead concentration from Silo 1 was 904 mg/L, while concentrations from Silo 2 were as high as 714 mg/L.

The results of the 1990/1991 TCLP tests on Silos samples are summarized in Attachment C - "Chemical Analysis Summary Spreadsheet". As with the 1989 samples, lead was detected in the material from both Silos 1 and 2 in concentrations that exceeded the maximum allowable concentration limits of 5 mg/L. The maximum concentrations of lead in the TCLP extract for the 1990/1991 samples were 841 and 1072 mg/L for Silos 1 and 2, respectively. Detection of regulated organics were less than the maximum allowable concentration limits.

Summary of Chemical Results

The 1989 and 1990/1991 sampling results from the Silos 2 show similar concentrations in: (1) the predominant *non-radioactive metallic* constituents of barium calcium, iron, and lead, and, (2) the predominant *organic* constituents of aroclors and tributyl phosphate (well below regulatory levels).

Treatment Process

The material in Silos 1 and 2 and the sludge in the Decant Sump Tank System will be hydraulically removed and placed in the TTA. Approximately 6,126 m³ (8,012 yd³) of 11(e)(2) by-product material and 671 m³ (878 yd³) of BentoGrout™ clay from Silos 1 and 2 and 3,785 L (1,000 gallons) of sludge from the decant sump will be removed and placed in the TTA pending treatment. The TTA will be equipped with a radon control system (RCS) designed to handle radon emissions generated during removal and storage.

The treatment component of the selected remedy consists of a chemical stabilization system to immobilize the constituents of concern (COCs) in Silos 1 and 2 material and the Decant Sump Tank System. For purposes of this selected remedy, chemical stabilization is defined as a non-thermal treatment process that mixes the Silos 1 and 2 material (including BentogROUT™) with a variety of chemical additive formulations (e.g., lime, pozzolans, gypsum, portland cement, or silicates) to accomplish chemical and physical binding of the COCs. The wastes removed from the TTA will be transferred to a chemical stabilization facility, which will be constructed on-site. The chemical binding of the COCs in the stabilized wasteform reduces their leach rate to meet the NTS WAC. In addition, the stabilized wasteform with sealed containerization reduces radon emanation to meet regulatory standards. Particulate released as a result of the stabilization process will be treated by an air emissions treatment system to satisfy all air emission ARARs and TBCs. Radon emanated during treatment will be collected and routed to the TTA RCS.

Why Are We Treating Silos 1&2?

In order to establish the legal framework by which to address the releases and threats of hazardous substances from containers and facilities at the FEMP, the DOE-FEMP (as the lead Federal agency for the remediation of the FEMP site) and the EPA entered into a Consent Agreement in 1990, as amended (EPA 1991). The Consent Agreement as Amended Under CERCLA Sections 120 and 106(a) (ACA) is the legal basis that administratively governs the proper management and restoration of the FEMP site.

Silos 1 and 2 material destined for remediation is by-product material as defined under Section 11(e)(2) of the Atomic Energy Act of 1954, and as such, is excluded from RCRA regulation [40 CFR Section 261.4(a)(4)]. By-product material, as defined by the AEA, includes tailings or wastes produced by the extraction or concentration of uranium and thorium from any ore processed primarily for its source material content (42 USC 2014).

Since the Silos 1 and 2 material is excluded from regulation as solid or hazardous waste, the requirements under RCRA are not applicable to Silos 1 and 2 RAs. However, based on analytical data, the material is sufficiently similar to RCRA hazardous waste because Silos 1 and 2 material exceeds toxicity characteristic levels for various toxicity characteristic metals under RCRA. Therefore, certain substantive requirements of RCRA were determined to be relevant and appropriate for management of the Silos 1 and 2 material considering their specific circumstances, and are included in the table of ARARs. The selected remedy will meet all relevant appropriate RCRA requirements.

The selected remedy satisfies the statutory requirements specified by the NCP [40 CFR Section 300.430(f)(5)(ii)]. The selected remedy is protective of human health and the environment, complies with all federal and state requirements that are applicable or relevant and appropriate to the RA, and is cost effective. This remedy uses permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment, and also reduce toxicity, mobility, or volume as a principal element.

The selected remedy achieves the requirement of being protective of human health and the environment by: (1) removing the sources of contamination, (2) stabilizing the waste, and (3) disposing of treated materials at an off-site location that provides the appropriate level

of protectiveness. The contents of Silos 1 and 2 and the Decant Sump Tank System will be removed and treated through a chemical stabilization process and disposed at an off-site disposal facility. Chemical stabilization will inhibit leaching of contaminants to the environment when they are disposed. The selected remedy also meets the statutory preference for treatment as a principle element.

Chemical stabilization and off-site disposal will provide permanent treatment for the Silos 1 and 2 material. By chemically binding the contaminants into a chemical stabilization matrix, the mobility of the contaminants significantly reduces the leachability of metal contaminants of concern to levels that are below RCRA regulatory thresholds. As a result, the selected remedy would meet the CERCLA criteria for permanent solutions that reduce the toxicity, mobility, or volume through treatment.

The statutory preference for remedies that employ treatment as a principal element is satisfied. By treating the contents of Silos 1 and 2 in a chemical stabilization process the selected remedy mitigates the principal threats posed by OU4 through the use of treatment technologies. The treatment provided by chemical stabilization accomplishes a significant, permanent reduction in mobility of the COCs.

E. REQUIRED CHEMICAL LABORATORY ANALYSIS

1. *Minimum Additional Analytical Required For:*
See Attachment C & D for analytical results and support data packages.
2. *Required Radiological Analysis:*
See Attachment B & D for analytical results and support data.

ATTACHMENT B**"RADIOCHEMICAL ANALYSIS SUMMARY
SPREADSHEET"**

ATTACHMENT B - "RADIOCHEMICAL ANALYSIS SUMMARY SPREADSHEET"

Nuclide	Frequency of Detection ^b	Rejected	Arithmetic Mean ^c (pCi/g) ^d	Upper 95% CI on A-Mean ^c (pCi/g)	Range of Detects ^e (pCi/g)
SILO 1					
Actinium-227	13/20	0	5,960	7,670	4,320 - 17,390
Lead-210	20/20	0	165,000	202,000	48,980 - 381,400
Polonium-210	13/13	0	242,000	281,000	144,000 - 434,000
Radium-226	20/20	0	391,000	477,000	89,280 - 890,700
Thorium-228	2/20	0	422	2,280	835 - 2280
Thorium-230	24/24	0	60,000	68,900	10,569 - 105,372
Thorium-232	8/20	0	424	1,110	661 - 1,116
Uranium-234	21/21	0	800	932	326 - 1,548
Uranium-235	14/20	0	38	54	19.1 - 105
Uranium-238	20/20	0	642	693	387 - 920
SILO 2					
Actinium-227	11/14	0	5,100	6,640	2,905 - 10,450
Protactinium-231	1/14	0	2,350	4,040	4,041 - 4,041
Lead-210	14/14	0	145,000	190,000	58,160 - 399,200
Polonium-210	8/8	0	139,000	231,000	55,300 - 241,000
Radium-226	14/14	0	195,000	263,000	657 - 481,000
Thorium-228	5/14	0	645	7,360	411 - 7,360
Thorium-230	15/15	0	48,400	76,200	8,365 - 132,800
Thorium-232	3/14	0	402	985	851 - 985
Uranium-234	13/13	0	961	1,160	121 - 1,465
Uranium-235	11/13	0	73	94	35.6 - 172
Uranium-238	14/14	0	912	1,120	46 - 1,925

TREATED SILO 1 & 2		
Nuclide	Maximum Activity ^c (pCi/g)	Average Activity ^f (pCi/g)
Actinium-227	3,478	2,956
Protactinium-231	809	687
Lead-210	79,840	67,864
Polonium-210	86,800	73,780
Radium-226	100,000	81,090
Thorium-228	1,472	1,251
Thorium-230	26,560	22,576
Thorium-232	222	188
Uranium-234	310	263
Uranium-235	35	29
Uranium-238	385	327

- a Sample data taken from Table 4-2 of the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a).
- b Rejected data not included in total number of samples.
- c Values qualified with an "R" (results unusable) are excluded. The mean and upper 95% confidence interval (CI) on mean have been rounded to show three significant figures. The mean is calculated using one-half the sample quantitation limit (SQL) for non-detects.
- d Values are expressed in picoCuries per gram (pCi/g).
- e Based on 20% waste loading.
- f Based on 17% waste loading.

INVENTORY OF K-65 RADIOLOGICAL CONSTITUENTS

Analyte	Silo 1		Silo 2	
	Mean Inventory ^c (Ci)	UCL Inventory ^c (Ci)	Mean Inventory ^c (Ci)	UCL Inventory ^c (Ci)
Actinium-227	40	52	30	39
Protactinium-231	ND ^d	ND ^d	14	24
Lead-210	1,110	1,360	844	1,110
Polonium-210	1,630	1,890	809	1,340
Radium-226	2,630	3,210	1,140	1,530
Thorium-228	2.8	15.3	3.8	43
Thorium-230	403	463	282	444
Thorium-232	2.9	7.5	2.3	5.7
Uranium-234	5.4	6.3	5.6	6.8
Uranium-235/236	0.26	0.36	0.43	0.55
Uranium-238	4.3	4.7	5.3	6.5
Total Uranium ^e	12.9	14.1	15.9	19.5

a Based on a volume of 3,280 m³ and a dry mass density of 2.050 g/cm³.

b Based on a volume of 2,840 m³ and a dry mass density of 2.050 g/cm³.

c Values for mean and UCL taken from Table 4-3 of the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a).

d ND - Analyte was not detected.

e Total uranium mass in metric tons. Calculated from the isotopic distribution of uranium.

ATTACHMENT B - "RADIOCHEMICAL ANALYSIS SUMMARY SPREADSHEET"

Nuclide	Frequency of Detection ^b	Rejected	Arithmetic Mean ^c (pCi/g) ^d	Upper 95% CI on A-Mean ^c (pCi/g)	Range of Detects ^c (pCi/g)
SILO 3					
Actinium-227	9/9	2	618	925	234-1363
Lead-210	11/11	0	262	3480	454-6427
Protactinium-231	9/11	0	487	627	266-931
Radium-224	11/11	0	290	367	64-453
Radium-226	11/11	0	2970	3870	467-6435
Radium-228	9/11	0	297	406	82-559
Thorium-228	7/11	0	590	747	459-996
Thorium-230	11/11	0	51200	60200	21010-71650
Thorium-232	8/11	0	656	842	411-1451
Uranium-234	11/11	0	1480	1730	348-1935
Uranium-235	10/11	0	93.6	117	42-2043
Uranium-238	11/11	0	1500	1780	320-2043

- a Sample data taken from Table 4-2 of the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a).
- b Rejected data not included in total number of samples.
- c Values qualified with an "R" (results unusable) are excluded. The mean and upper 95% confidence interval (CI) on mean have been rounded to show three significant figures. The mean is calculated using one-half the sample quantitation limit (SQL) for non-detects.
- d Values are expressed in picoCuries per gram (pCi/g).

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ATTACHMENT C

"CHEMICAL ANALYSIS SUMMARY SPREADSHEET"

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ATTACHMENT C - "CHEMICAL ANALYSIS SUMMARY SPREADSHEET"

Analyte	Frequency of Detection ^b	Rejected	Arithmetic Mean ^c (mg/kg) ^d	Upper 95% CI on A Mean ^c (mg/kg)	Range of Detection (mg/kg)
SILO 1					
General Chemistry					
Ammonia	4/7	0	1.19	8.9	1.1 - 8.9
Chloride	7/7	0	637	1,340	269 - 1,349
Fluoride	2/7	0	1	394	15 - 394
Nitrate	5/5	2	2,930	4,764	2,216 - 4,764
Oil and grease	7/8	0	3,650	27,000	11.7 - 27,000
Phosphorus	8/8	0	1,130	3,290	0.4 - 3,290
Sulfate	6/6	1	1,300	3,460	444 - 3,460
Total kjeldahl nitrogen	7/7	0	479	676	51.6 - 782.5
Total organic carbon	8/8	0	19,200	26,200	5,166 - 34,800
Total organic nitrogen	8/8	0	448	623	51.6 - 782
Metals					
Aluminum	13/19	0	1,050	1,320	450 - 2,460
Antimony	11/12	7	21	26	13.3 - 46.2
Arsenic	18/19	0	22	55	3.1 - 68.4
Barium	19/19	0	11,600	14,200	1970 - 22,100
Beryllium	17/19	0	1	1	0.59 - 2.8
Boron	12/12	0	46	50	23.8 - 61.7
Cadmium	11/18	1	2	4	0.56 - 8
Calcium	19/19	0	2,960	3,650	799 - 5,700
Chromium	19/19	0	42	55	19.7 - 165
Cobalt	19/19	0	936	1,100	349 - 1,870
Copper	19/19	0	285	331	122 - 475
Cyanide	19/19	0	2	3	0.52 - 4.4
Iron	19/19	0	14,700	21,100	4,280 - 75,100
Lead	19/19	0	81,700	95,500	17,400 - 33,000
Magnesium	19/19	0	2,880	3,380	1,500 - 6,020
Manganese	19/19	0	72	97	25.6 - 257
Mercury	18/19	0	0.6	0.9	0.15 - 2.8
Molybdenum	12/12	0	4,850	6,290	968 - 8,600
Nickel	19/19	0	1,790	2,290	629 - 3,380
Potassium	19/19	0	429	493	158 - 715
Selenium	19/19	0	287	340	58.5 - 2,810
Silicon	12/12	0	723	853	359 - 1,290
Silver	19/19	0	11	13	5 - 23.3
Sodium	19/19	0	8,670	10,700	360 - 16,700
Thallium	8/18	1	0.3	1.4	0.09 - 1.4
Vanadium	19/19	0	136	161	63.1 - 293
Zinc	14/19	0	28	37	7.7 - 212

ATTACHMENT C - "CHEMICAL ANALYSIS SUMMARY SPREADSHEET"

Analyte	Frequency of Detection ^b	Rejected	Arithmetic Mean ^c (mg/kg) ^d	Upper 95% CI on A Mean ^c (mg/kg)	Range of Detection (mg/kg)
SILO 2					
General Chemistry					
Chloride	6/6	0	65	141	28 - 141
Nitrate	5/5	1	5,430	8,900	3,490 - 8,900
Oil and grease	4/4	0	301	541	207 - 541
Phosphorus	5/5	0	1,130	1,400	623 - 1,400
Sulfate	6/6	0	8,610	19,300	2,590 - 19,300
Total kjeldahl nitrogen	3/3	0	204	220	176 - 220
Total organic carbon	5/5	0	6,090	24,400	148 - 24,400
Total organic nitrogen	4/4	1	232	289	176 - 289
Metals					
Aluminum	8/14	0	845	1,110	363 - 2,250
Antimony	7/8	6	26	44	14.4 - 77.4
Arsenic	14/14	0	432	1,550	57.5 - 1,960
Barium	14/14	0	6,970	19,900	89.2 - 19,900
Beryllium	14/14	0	2	3	0.59 - 6
Boron	5/8	0	38	51	18.4 - 81.2
Cadmium	13/14	0	5	7	2 - 19.1
Calcium	14/14	0	33,300	301,000	64 - 301,000
Chromium	14/14	0	40	51	0.207 - 83.1
Cobalt	14/14	0	984	2,430	6.2 - 2,430
Copper	13/13	1	531	818	220 - 1,790
Cyanide	13/13	1	3	5	0.9 - 7.1
Iron	13/13	1	16,500	28,900	4,010 - 40,000
Lead	14/14	0	48,200	299,000	153 - 299,000
Magnesium	14/14	0	3,800	6,410	805 - 8,740
Manganese	14/14	0	163	259	40.6 - 403
Mercury	13/13	1	0.9	1.2	0.18 - 2.3
Molybdenum	8/8	0	291	440	148 - 479
Nickel	14/14	0	1,380	1,720	14.6 - 2,640
Potassium	14/14	0	217	337	37.8 - 653
Selenium	13/13	1	110	124	49.6 - 155
Silicon	8/8	0	851	1,148	507 - 1,780
Silver	13/13	1	17	22	7.4 - 34.9
Sodium	14/14	0	2,430	3,200	226 - 4,940
Thallium	9/12	1	1	2	0.33 - 5.7
Vanadium	14/14	0	237	298	21.9 - 535
Zinc	14/14	0	54	91	11.2 - 159

a Sample data taken from Table 4-4 of the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a).

b Rejected data not included in total number of samples.

c Values qualified with an "R" are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.

d Values expressed in milligrams per kilogram (mg/kg).

ATTACHMENT C - "CHEMICAL ANALYSIS SUMMARY SPREADSHEET"

Analyte	Frequency of Detection ^b	Rejected	Arithmetic Mean ^c (mg/kg) ^d	Upper 95% CI on A Mean ^c (mg/kg)	Range of Detection (mg/kg)
SILO 3					
Metals					
Aluminum	11/11	0	17200	19800	10800-23700
Antimony	1/11	10	5.5	e	e
Arsenic	11/11	0	1950	3170	532-6380
Barium	11/11	0	217	278	118-332
Beryllium	11/11	0	24.2	29.1	10-39.9
Cadmium	11/11	0	60	94	21.5-204
Calcium	11/11	0	29400	33400	21300-39900
Chromium	11/11	0	288	395	139-560
Cobalt	10/11	1	2100	2890	1100-3520
Copper	19/19	0	2550	3340	16100-7060
Iron	11/11	0	37800	52200	13900-67600
Lead	11/11	0	1730	2380	646-4430
Magnesium	11/11	0	58600	68900	38200-80900
Manganese	11/11	0	4380	5160	2420-6500
Mercury	3/11	8	0.4	0.7	0.3-0.69
Nickel	10/11	1	3150	4290	1760-6170
Potassium	11/11	0	7260	14000	1300-22800
Selenium	11/11	0	174	229	101-349
Silver	11/11	0	16	18	9.2-23.8
Sodium	11/11	0	36100	40800	22900-51700
Thallium	10/11	1	21	56	4-73.9
Vanadium	11/11	0	1820	3490	418-4550
Zinc	11/11	0	450	535	301-672

- a Sample data taken from Table 4-4 of the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a).
- b Rejected data not included in total number of samples.
- c Values qualified with an "R" are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.
- d Values expressed in milligrams per kilogram (mg/kg).

ATTACHMENT D**"LABORATORY ANALYTICAL SUPPORT DATA
PACKAGE"****000041**

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ATTACHMENT E

"UTAH LAB CERTIFICATION"

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ATTACHMENT F

"MSDS"

MATERIAL SAFETY DATA SHEET
RADSORB™

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Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME RADSORB™
CHEMICAL FAMILY Acrylamide Potassium Acrylate
Copolymer
CHEMICAL FORMULA Not Applicable
EFFECTIVE DATE 04/16/98

MANUFACTURER:
CORPEX Technologies Inc.
P.O. Box 13486
Research Triangle Park,
North Carolina 27709
Tel. 919-941-0847

EMERGENCY TELEPHONE NUMBERS:

Transportation: CHEMTREC 800-424-9300 24 hours every day
Transportation. 919-941-0847 8:30am - 5:00pm EST M-F
Health 919-941-0847 8:30am - 5:00pm EST M-F

Section 2 - HAZARDOUS INGREDIENT INFORMATION

Component	CAS#	Recommended Limits
Acrylamide Potassium Acrylate Copolymer, Crosslinked	31212-13-2	0.05 mg/m ³
* Manufacturer recommended inhalation exposure guideline, small, less than 10 microns, respirable polyacrylate. See Section 11 of MSDS.		

Section 3 - HAZARDS IDENTIFICATION**EMERGENCY OVERVIEW**

Caution! Inhalation may cause mild irritation of upper respiratory tract. Causes eye irritation and dryness of affected area. White granulated powder

POTENTIAL HEALTH EFFECTS

EYE CONTACT
SKIN CONTACT

Causes eye irritation. Avoid direct contact.
Frequent or prolonged contact may irritate the skin and cause a skin rash (dermatitis)

INHALATION
INGESTION

May cause mild irritation of upper respiratory tract.
Harmful if swallowed

CARCINOGENICITY

NTP
IARC
OSHA

Not listed.
Not listed
Not listed.

Section 4 - FIRST AID MEASURES

EYE CONTACT

Flush immediately with plenty of water for at least 15 minutes and get prompt medical attention

SKIN CONTACT

Wash thoroughly with soap and water.

INHALATION

Remove to fresh air. For breathing difficulty, give oxygen or if breathing has stopped give artificial respiration. Get medical attention immediately!

INGESTION

Get medical attention immediately! DO NOT INDUCE VOMITING!
Never give anything by mouth to an unconscious person

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Section 5 - FIRE FIGHTING MEASURES

FLASH POINT	Non Flammable
LOWER FLAME LIMIT	Not applicable.
HIGHER FLAME LIMIT	Not applicable.
AUTOIGNITION TEMPERATURE	Not applicable.
FLAMMABILITY CLASSIFICATION	Non-Flammable, non-combustible, non-volatile
FLAMMABLE PROPERTIES	Non-Flammable, non-combustible, non-volatile.
EXTINGUISHING MEDIA	Use extinguishing media for primary source of fire
SPECIAL FIRE FIGHTING PROCEDURES	Extremely slippery conditions are created if spilled material comes in contact with water.
HAZARDOUS COMBUSTION PRODUCTS	None.
UNUSUAL FIRE & EXPLOSION HAZARD	None.

Section 6 - ACCIDENTAL RELEASE MEASURES

RELEASES: Collect material. Observe precautions in the Personal Protection Section of this MSDS.
CAUTION: very slippery conditions are created if spilled material comes in contact with water.

Section 7 - HANDLING AND STORAGE

HANDLING: Avoid contact with water, very slippery conditions are created if material comes in contact with water. Wash thoroughly after handling. Use only in well ventilated area. Avoid contact with eyes, skin and clothing

STORAGE: Keep in dry and well ventilated area. Keep container tightly closed. Comply with all national, state, and local codes pertaining to the storage, handling, dispensing, and disposal of this material

Section 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION

ENGINEERING CONTROLS	Good general ventilation should be used. Ventilation rates should be matched to conditions
EYE PROTECTION	Wear safety glasses with side shields or goggles. Avoid eye contact.
SKIN PROTECTION	Gloves are recommended
RESPIRATORY PROTECTION	Nuisance dust mask recommended when dust is created

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	Granular powder.
COLOR	White.
ODOR	None.
VAPOR PRESSURE (mm Hg)	<10
VAPOR DENSITY (Air=1)	Not established.
BOILING POINT	Solid
MELTING POINT	>390°F.
SOLUBILITY IN WATER	Insoluble, but swellable in aqueous fluids
SPECIFIC GRAVITY(water=1)	0.4 - 0.7
EVAPORATION RATE (Butyl Acetate=1)<1	

Section 10 - STABILITY AND REACTIVITY

CHEMICAL STABILITY	Stable.
CONDITIONS TO AVOID	High temperatures, ignition sources.
INCOMPATIBLE MATERIALS	Strong oxidizing agents
DECOMPOSITION PRODUCTS	Oxides of nitrogen and carbon may form during burning
HAZARDOUS POLYMERIZATION	Will not occur

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Section 11 - TOXICOLOGICAL INFORMATION

Acute (short term) inhalation of polyacrylate dust may cause mild irritation of upper respiratory tract (nose and throat) and lungs.

Chronic (long term) inhalation exposure to rats for a lifetime (two years) using a sodium polyacrylate that had been micronized to a respirable particle size (less than 10 microns) produced non-specific inflammation and chronic lung injury at 0.2 mg/m³ and 0.8 mg/m³. At 0.8 mg/m³, tumors were seen in some animals. In the absence of chronic inflammation, tumors are not expected. There were no adverse effects of any kind at 0.05 mg/m³.

Sodium polyacrylate had no effect in mutagenicity tests.

Section 12 - ECOLOGICAL INFORMATION

Not Established

Section 13 - DISPOSAL CONSIDERATIONS

TCLP

No component is regulated.

BIODEGRADABILITY

Product is not biodegradable under the OECD

RCRA STATUS

No component is regulated as hazardous waste under RCRA (40 CFR 261). If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA it is the responsibility of the product user to determine, at the time of disposal, whether a material containing the product or derived from the product should be classified as hazardous waste.

Section 14 - TRANSPORT INFORMATION

D.O.T. SHIPPING NAME

None.

D.O.T. HAZARD CLASS

Non Hazardous.

N.A. I.D. NUMBER

Not Applicable.

U.N. I.D. NUMBER

Not Applicable.

PRODUCT LABEL

RADSORB™

Section 15 - REGULATORY INFORMATION

TSCA STATUS

All components of this product are listed on TSCA inventory.

CERCLA REPORTABLE QUANTITY

None

OSHA STATUS

Hazardous.

SARA TITLE III

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES None

SECTION 311/312 HAZARD CATEGORIES

Immediate (acute) health Yes

Delayed (chronic) health No

Fire hazard. No

Sudden release of pressure: No

Reactive: No

SECTION 313 TOXIC CHEMICALS

None

RCRA STATUS

No component is regulated as hazardous waste under RCRA (40 CFR 261). If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as hazardous waste.

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Section 16 - OTHER INFORMATION

REASON FOR ISSUE:

New Format

APPROVAL DATE:

04/16/98

SUPERSEDES DATE:

03/30/94

HMTS HAZARD RATING:

Health 1
 Flammability 0
 Reactivity 0
 PPE C

1 = Extreme
 2 = Moderate

3 = High
 1 = Low
 0 = Least

PPE:

A = Glasses
 B = Glasses, Gloves
 C = Glasses, Gloves, Apron Clothing

NFPA HAZARD RATING:

Health 1
 Flammability 1
 Reactivity 0
 Specific Hazard 0

Health	Fire (flash point)	Reactivity	Specific Hazard
4 Deadly	<73°F	May Detonate	Oxidizer: OXY
3 Extreme Hazard	<100°F	Shock & Heat	Acid: ACID
2 Hazardous	<200°F	Violent Chemical	Alkali: ALK
1 Slightly Hazardous	>200°F	Unstable if heated	Corrosive: COR
0 Normal Material	will not burn	Stable	NO WATER W/ Radiation: RAD

NOTE - -

All information appearing herein is based upon data obtained from manufacturers and/or recognized technical sources. We believe the information is current and accurate as of the date of this MSDS. It is given in good faith, but, no warranty expressed or implied is made. Since the use of this information and the conditions of the use of the product are not under the control of CORPEX Technologies Inc. it is the user's responsibility to determine conditions of safe use of the product. Please consult your CORPEX Technologies Inc. representative for further information.

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Please reduce your browser font size for better viewing and printing.

MSDS

Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08855

MALLINCKRODT



24 Hour Emergency Telephone: 800-859-2151
CHEMTREC: 1-800-424-8300

National Response in Canada
CANUTEC: 613-804-6595

Outside U.S. and Canada
Chemtrec: 202-683-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-382-2537) for assistance.

TRIBUTYL PHOSPHATE

MSDS Number: T4706 --- Effective Date: 02/25/99

1. Product Identification

Synonyms: Phosphoric acid tributyl ester; Tri-n-butyl phosphate
CAS No.: 126-73-8
Molecular Weight: 266.32
Chemical Formula: $(CH_3CH_2CH_2CH_2O)_3PO$
Product Codes:
J.T. Baker: W432
Mallinckrodt: 1940

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Tributyl Phosphate	126-73-8	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. MAY AFFECT CENTRAL NERVOUS SYSTEM.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

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Health Rating: 2 - Moderate
 Flammability Rating: 1 - Slight
 Reactivity Rating: 1 - Slight
 Contact Rating: 2 - Moderate
 Lab Protective Equip: GOGGLES; LAB COAT
 Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:

Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. May cause headache. May also mildly affect blood cholinesterase levels, which will affect central nervous system operation.

Ingestion:

May cause abdominal pain, vomiting. Other symptoms parallel inhalation.

Skin Contact:

Causes irritation to skin. Symptoms include redness, itching, and pain. May be absorbed through the skin with possible systemic effects.

Eye Contact:

Causes irritation, redness, and pain.

Chronic Exposure:

No information found.

Aggravation of Pre-existing Conditions:

Persons with pre-existing central nervous system disorders may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Give large amounts of water to drink. Never give anything by mouth to an unconscious person. Get medical attention.

Skin Contact:

Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Flash point: 120C (248F) OC

Slight fire hazard when exposed to heat or flame.

Explosion:

Above the flash point, explosive vapor-air mixtures may be formed.

Fire Extinguishing Media:

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Water spray, dry chemical, alcohol foam, or carbon dioxide. Water or foam may cause frothing.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer!

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):

5 mg/m³ (TWA)

-ACGIH Threshold Limit Value (TLV):

2.2 mg/m³ (0.2 ppm) (TWA)

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a half-face respirator with an organic vapor cartridge and particulate filter (NIOSH type P95 or R95 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece respirator with an organic vapor cartridge and particulate filter (NIOSH P100 or R100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. Please note that N series filters are not recommended for this material. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in

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oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible.

Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Colorless to yellowish liquid.

Odor:

Odorless.

Solubility:

Slightly soluble in water.

Specific Gravity:

0.98 @ 25C/25C

pH:

No information found.

% Volatiles by volume @ 21C (70F):

No information found.

Boiling Point:

289C (552F)

Melting Point:

-80C (-112F)

Vapor Density (Air=1):

9.2

Vapor Pressure (mm Hg):

0.8 @ 114C (237F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Burning may produce carbon monoxide, carbon dioxide, phosphorous oxides.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizers, strong bases. May soften some plastics and elastomers. Avoid wet alkaline conditions, especially when the material is heated, because tributyl phosphate undergoes hydrolysis to produce butyl alcohol and alkyl phosphoric acid salts.

Conditions to Avoid:

Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

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Oral rat LD50: > 1400 mg/kg; Inhalation rat LD50: 28 gm/m3/1-hour; Skin rabbit LD50: > 3100 mg/kg. Investigated as a mutagen, reproductive effector.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Tributyl Phosphate (126-73-8)	No	No	None

12. Ecological Information

Environmental Fate:

When released into the soil, this material may biodegrade to a moderate extent. When released into the soil, this material is not expected to leach into groundwater. When released into water, this material may biodegrade to a moderate extent. This material has an experimentally-determined bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of less than 1 day.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----

Ingredient	TSCA	EC	Japan	Australia
Tributyl Phosphate (126-73-8)	Yes	Yes	Yes	Yes

-----\Chemical Inventory Status - Part 2\-----

Ingredient	Korea	--Canada--		Phil.	0000!
		DSL	NDSL		
Tributyl Phosphate (126-73-8)	Yes	Yes	No	Yes	

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-----\Federal, State & International Regulations - Part 1\-----				
Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Tributyl Phosphate (126-73-8)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----			
Ingredient	CERCLA	-RCRA-	-TSCA-
		261.33	8(d)
Tributyl Phosphate (126-73-8)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): Yes CDTA: Yes
 SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
 Reactivity: No (Pure / Liquid)

Australian Hazchem Code: No information found.

Poison Schedule: No information found.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 2 Flammability: 1 Reactivity: 1

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. MAY AFFECT CENTRAL NERVOUS SYSTEM.

Label Precautions:

Avoid breathing dust.
 Avoid contact with eyes, skin and clothing.
 Keep container closed.
 Use only with adequate ventilation.
 Wash thoroughly after handling.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, give large amounts of water to drink. Never give anything by mouth to an unconscious person. In all cases, get medical attention.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3, 8.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving

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the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED; INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

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ALBRIGHT & WILSON AMERICAS MATERIAL SAFETY DATA BULLETIN

ALBRIGHT & WILSON AMERICAS
ENVIRONMENTAL SERVICESP. O. BOX 26229
RICHMOND, VA 23260-6229 (USA)

***** PRODUCT IDENTIFICATION *****

ExperimentalAWA-1009Sample for R&D only

SUPPLIER:

ALBRIGHT & WILSON AMERICAS
CHEMICAL NAMES AND SYNONYMS:Dipentyl Pentylphosphonate

USE OR DESCRIPTION:

Industrial Chemical

HEALTH EMERGENCY TELEPHONE:

(803) 745-5200

TRANSPORT EMERGENCY TELEPHONE:

(800) 424-9300 (CHEMTREC)

OTHER DESIGNATION:

None

***** TYPICAL CHEMICAL AND PHYSICAL PROPERTIES *****

APPEARANCE:

Clear Liquid

VISCOSITY: AT 100 F, SUS

NE

AT 40 C, CPS

NE

ODOR:--

Mild

VISCOSITY: AT 210 F, SUS

NE

AT 100 C, CPS

NE

RELATIVE DENSITY: 15/4 C SOLUBILITY IN WATER:

NENE

PH:

NE

MELTING POINT: F(C)

NE

POUR POINT: F(C)

NE

BOILING POINT: F(C)

>302(150) @ 2 mmHg

FLASH POINT: F(C) (METHOD)

NE

VAPOR PRESSURE: MM HG 20C

<2 mmHg @ 150°C

• NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

***** INGREDIENTS *****

HAZARDOUS INGREDIENTS:

Dipentyl PentylphosphonateUnidentified ImpuritiesWT PCT
(APPROX)

TLV(TWA)

MG/M3

PPM

96NENE4NENE

NOTE: TLVS SHOWN FOR GUIDANCE ONLY. FOLLOW APPLICABLE REGULATIONS.

INFORMATION GIVEN HEREIN IS OFFERED IN GOOD FAITH AS ACCURATE, BUT WITHOUT GUARANTEE. CONDITIONS OF USE AND SUITABILITY OF THE PRODUCT FOR PARTICULAR USES ARE BEYOND OUR CONTROL, ALL RISKS OF USE OF THE PRODUCT ARE THEREFORE ASSUMED BY THE USER AND WE EXPRESSLY DISCLAIM ALL WARRANTIES OF EVERY KIND AND NATURE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. RESPECT TO THE USE OR SUITABILITY OF THE PRODUCT. NOTHING IS INTENDED AS A RECOMMENDATION FOR USES WHICH INFRINGE VALID PATENTS OR AS EXTENDING LICENSE UNDER VALID PATENTS. APPROPRIATE WARNINGS AND SAFE HANDLING PROCEDURES SHOULD BE PROVIDED TO HANDLERS AND USERS.

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AWA-1009

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***** FIRE AND EXPLOSION HAZARD DATE *****

FLASH POINT: F(C) METHOD) FLAMMABLE LIMITS: LEL UEL
NE NE NE

EXTINGUISHING MEDIA:

CO2 Foam Dry Chemical

SPECIAL FIRE FIGHTING PROCEDURES:

Firefighters must use self-contained breathing equipment and recommended protective equipment.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Exposure to fire can generate highly toxic fumes.

***** EMERGENCY AND FIRST AID PROCEDURES *****

EYE CONTACT:

Flush with water. consult a physician.

SKIN CONTACT:

Remove contaminated clothes. wash with soap and water. If widespread, contact a physician. Launder contaminated clothing before reuse.

INHALATION:

Not expected to be a problem.

INGESTION:

Do not induce vomiting. If swallowed, immediately give 1 to 2 glasses of water and call a physician, hospital emergency room or poison control center for assistance.

***** REACTIVITY DATA *****

STABILITY: (THERMAL, LIGHT, ETC.)

Stable

CONDITIONS TO AVOID:

INCOMPATIBILITY:

Strong oxidizers

MATERIALS TO AVOID:

HAZARDOUS DECOMPOSITION PRODUCTS:

Phosphorus oxides, carbon monoxide

HAZARDOUS POLYMERIZATION:

NA

CONDITIONS TO AVOID:

NA

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***** SPILL OR LEAK PROCEDURE *****

ENVIRONMENTAL IMPACT:

REPORT SPILLS AS REQUIRED TO APPROPRIATE AUTHORITIES. U.S. COAST GUARD REGULATIONS REQUIRE IMMEDIATE REPORTING OF SPILLS THAT COULD REACH ANY WATERWAY INCLUDING INTERMITTENT DRY CREEKS. REPORT SPILL TO COAST GUARD TOLL FREE NUMBER 800-424-8802. IN CASE OF ACCIDENT OR ROAD SPILL NOTIFY CHEMTREC 800-424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:

Absorb on flame retardant treated sawdust, diatomaceous earth, etc.
scrape up and remove. Dispose of at an appropriate waste disposal
facility in accordance with current applicable laws and regulations.
and product characteristics at time of disposal.

WASTE MANAGEMENT:

Return unused sample to address on label. Dispose of wastes at an
appropriate waste disposal facility in accordance with current
applicable laws and regulations, and product characteristics at time
of disposal.

***** SPECIAL PROTECTION INFORMATION *****

EYE PROTECTION:

Normal industrial eye protection practices should be employed.

SKIN PROTECTION:

Impervious gloves should be worn. Good personal hygiene practices
should always be followed.

RESPIRATORY PROTECTION:

No special requirements under ordinary conditions of use and with
adequate ventilation.

VENTILATION:

Use in well ventilated area.

OTHER: NE

***** SPECIAL PRECAUTIONS *****

HANDLING: NE

STORAGE: No special requirements.

STORED MATERIAL MUST BE LABELED AS: AWA-1009 Explosive
Industrial Chemical

000057

AWA-1009

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***** HEALTH HAZARD DATA *****

ACUTE HEALTH HAZARDS

Oral LD50 (rat): >500 mg/kg. Dermal LD50 (rabbit): >1,000 mg/kg. Primary
Dermal Irritation (rabbit): Irritant. Eye Irritation (rabbit): Irritant

CARCINOGENICITY

LISTED: NTP? No IARC MONOGRAPHS? No OSHA REGULATED? No

SIGNS AND SYMPTOMS OF EXPOSURE

NE

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

NE

SUBACUTE AND MUTAGENICITY (SUMMARY)

NE

CHRONIC OR SPECIALIZED (SUMMARY)

NE

OTHER DATA

None

ENVIRONMENTAL SERVICES

PHONE: 804-550-4246

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13572

4237

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APPENDIX
PRECAUTIONARY LABEL TEXT FOR PACKAGED PRODUCTS

This material is an experimental product, the biological properties of which have not been fully investigated. Therefore, this sample should be handled only by competent, trained personnel. This sample should be used only for the purposes specified in the transmittal letter and any unused sample should be returned to the address specified below. TSCA regulations specify that experimental material and products prepared from them cannot be offered for sale.

CAS Registry No.: 6418-56-0

This material is not on the TSCA inventory.

Mailing Address:

ALBRIGHT & WILSON AMERICAS
P. O. BOX 26229
RICHMOND, VA 23260-6229

Shipping Address:

ALBRIGHT & WILSON AMERICAS
100 LAKERIDGE PARKWAY
ASHLAND, VA 23005

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